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DEPARTMENT OF AGRICULTURE.

BULLETIN No. 113.

METHODS OF MILKING,

WITH SPECIAL REFERENCE TO THE MANIPULATION METHOD.

By Prof. F. W. Woll,
Chemist to Wisconsin Experiment Station, Madison, Wis.

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PREFACE.

Commonwealth of Pennsylvania,
Department of Agriculture,
Harrisburg, Pa., Aug. 1, 1903.

The following Bulletin, No. 113, deals with a subject which, although its importance is recognized by all dairymen, has hitherto received but little attention.

Every practical dairyman has observed that individual members of his herd make a better showing when the milking is done by an operator that is careful and painstaking than when it is done by one who feels no interest in his work, and is indifferent as to its results. The method employed for drawing the milk from the udder of the cow not only affects the profits she brings to her owner in any given season, but in the case of the young cow especially it has much to do with developing her milking qualities, thereby increasing her permanent value.

This subject has recently been attracting the attention of practical men in the best dairy countries of the world, and in order that the dairymen of Pennsylvania may have the benefit resulting from scientific investigation and experiments made, this Department has arranged for the preparation and publication of this bulletin.

N. B. CRITCHFIELD,
Secretary of Agriculture.

LETTER OF TRANSMITTAL.

Agricultural Experiment Station,
Madison, Wis., May 28, 1903.

Hon. N. B. Critchfield,
Secretary of Agriculture, Harrisburg, Pa.:

Dear Sir: I have the honor to submit herewith a bulletin on the "Process of Milking," with special reference to the manipulation method, which has been prepared under authorization from you, and in accordance with suggestions approved by you.

Respectfully yours,

F. W. WOLL,
Chemist.

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Acknowledgement is due to the following parties for the loan of cuts used in this bulletin: Director Experiment Stations at Storrs, Conn., and Madison, Wis., Ed. Hoard's Dairyman Ft. Atkinson, Wis., Borden & Selleck Co., Chicago, Ill., the Dairy Specialty Co., West Chester, Pa., and Wm. M. Mehring, York Road, Md.

METHODS OF MILKING.

By Prof. F. W. Woll, Madison, Wis.

INTRODUCTORY.

According to the Twelfth Census there were about one million dairy cows, two years old or over, in Pennsylvania, in 1900. It is fair to assume that the average annual production of these cows did not exceed 4,000 pounds of milk, of an average fat content of about 3.75 per cent. For 1,000,000 cows this would mean an annual production of butter-fat amounting to 150,000,000 pounds. Taking twenty cents as an average value per pound of butter-fat, which may be considered a rather low estimate, the total production of butter-fat by Pennsylvania cows will be worth about $30,000,000 per year. If, by some improvement in the method of handling the cows their production could be increased by, say 10 per cent., the gain to the dairy industry of the State would be $3,000,000 annually. Evidence will be presented in this bulletin which shows to a considerable degree of certainty that present methods of milking, as practiced on a large majority of our dairy farms, can be improved upon at least to the extent suggested, which would, therefore, increase the value of the dairy products of the State by the sum just given. This would not necessarily be net gain, as it may be supposed that it will cost something to obtain the additional 10 per cent. of products, but we shall see as we proceed that an increase in production as suggested, may actually be secured by but little extra expenditure of feed or labor, and may, for all practical purposes, be considered clear gain.

It is the primary object of this bulletin to inform Pennsylvania dairymen how the production of the dairy may be increased by giving closer attention to the work of milking than is now often the case, and particularly, by modifying somewhat the ordinary manner of milking in such a way that the last drops of milk found in the udder of the cow at the time of the milking may be readily obtained. Before we proceed to explain how this may be brought about, it may be well to consider briefly in how far a careful system of milking is of importance in successful dairying, and how present conditions can be improved upon. An intelligent discussion of these points calls for a somewhat definite knowledge

of the process of elaboration of milk on the part of the reader, and we find it, therefore, necessary, at the outset, to devote some space to a description of the udder of the cow and the physiology of milk secretion. In doing this we shall avoid technical expressions, so far as possible, and shall only touch upon matters of direct practical interest and importance to the keeper of cows.

THE STRUCTURE OF THE COW'S UDDER.

The udder of the cow consists of four more or less highly developed glands, commonly spoken of as quarters; each of these is provided with outlets through a teat. We speak of the right and left fore quarters and the right and left hind quarters, or, considering the two quarters lying on the same side, of the right and left halves of the udder. The interior of the udder is composed of a

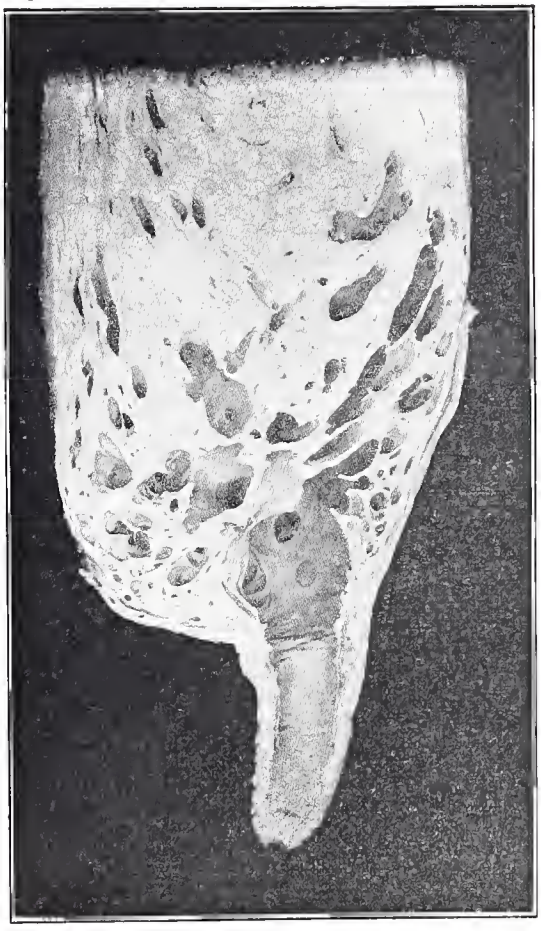

FIG. 1. Section of a Cow's Udder (After Ward.)

spongy, fibrous mass, the so called milk glands; if one of these glands is cut in two in any direction, innumerable ducts and cavities are shown, some large, some so small that they can hardly be seen (Fig. 1). If a thin section of the gland be placed under a

microscope we notice that there are still more of these ducts and cavities than could be discovered by the naked eye. By studying the anatomy of the glands in this manner we first find directly above each teat, so-called milk cisterns. The milk cisterns vary in capacity in different cows according to the size and shape of the udder, but they seldom hold more than about one-half of a pint. From these cisterns, milk canals or ducts extend upwards in all directions and branch off into finer ducts, until they can no longer be seen by the naked eye. These fine ducts all end in innumerable microscopic sack-like cavities called *alveoli.* It is in the latter that the elaboration of milk takes place; they are the work shops in which the milk is manufactured. Each alveolus is surrounded by a dense net-work of arteries, veins, nerves and lymph vessels, which supply the gland with the food materials required for the elaboration of the milk or carry away the waste products there formed. The alveoli are separated by different kinds of tissues, which have nothing to do with the secretion of the milk, but only support the udder and help to give it its peculiar shape. The presence of considerable of such connective or fatty tissue gives meaty quality to an udder, which is undesirable in a dairy cow.

The *alveoli* of the udder are egg-shaped and only about five-thousandth of an inch long; they consist of a thin structureless membrane, lined with a single layer of epithelial cells. When milk is secreted, these cells are greatly enlarged and the alveoli are filled with detached cells, which are in all stages of disintegration showing broken up cell tissue, fat globules, etc., when the cow is dry, the epithelial cells fall together and there is no breaking down of cells and their contents into milk components. (See Fig. 2.) An udder

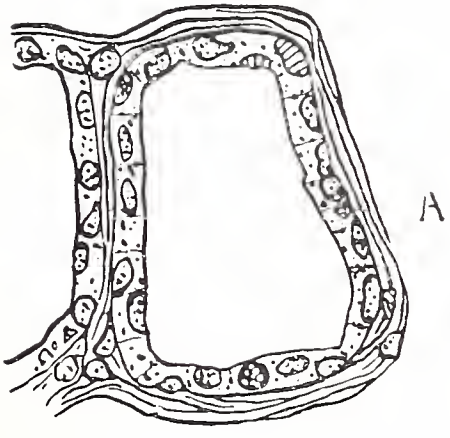

Fig. 2a

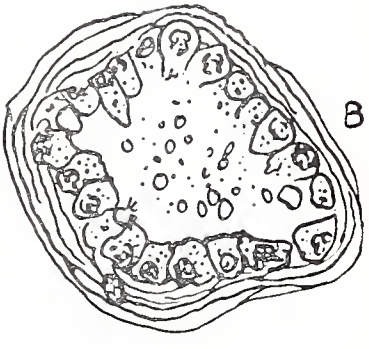

Fig. 2b.

Alevoli, the milk-producing glands in the udder; 2a, gland recently emptied, cells fallen together; 2b, gland and cells filled with milk and milk-making materials (Danils.)

which will fall together after milking, so as to hang like a dish rag, is made up largely of milk-secreting glands and has a minimum of

connective and fatty tissues; udders of this type are, therefore, a sign of a good dairy cow.

THE SECRETION OF MILK.

The mammary glands of the dairy cow have been developed through similar agencies as have been at work in the improvement of our other domestic animals, from a small beginning, at the time cows were first kept for the use of man, when their secretion was only sufficient for the demands of their young ones and ceased altogether as soon as these could provide for their own feed, until the present time, when a good dairy cow will give at least five times her own weight of milk in a year, and in single instances half her weight of butter-fat, or more, every year. The main forces which have produced this wonderful transformation have been selection, breeding, feeding and regular and persistent milking. As, in case of other living beings, we may note the progress made during past ages, in the development of the individual. The udder of the heifer with her first calf is not fully developed, but with every calving there is a gradual improvement in the milk-secreting capacity of the cow, until the maximum is reached, ordinarily after third or fourth calving.

The secretion of milk, as a rule, begins directly after parturition, and is intended by nature for the nourishment of the young calf. The character of the secretion obtained during the first four or five milkings differs from that of ordinary milk, both in composition and color, and is known as colostrum milk. In modern dairying, the calf is only allowed to suck the dam for a few days at most, and the cow gives up the milk formed in her bag for the use of man, by the process of milking. In this process the udder is emptied of its milk regularly two or three times a day, this being done with more or less thoroughness according to the care of the milker. We shall have occasion to refer to different methods of milking later, and will only say here that the milking is done by certain ways of handling the teats and the base of the udder, in some cases preceded by gentle stroking of the sides of the udder, which assists in "bringing down" the milk. The milk gathered in the milk cisterns are pressed out of the teats by alternate closing and opening of the hands of the milker, and when full streams of milk are thus obtained, the milking may and should always proceed without interruption until the flow of milk practically stops.

It is well known that most cows will give down small squirts of milk, "strippings," for a considerable time after a full flow of milk has ceased. This milk is elaborated from the last portions of the milk-producing materials which the *alveoli* have manufactured at the time of the milking. The formation of material from which milk is formed goes on all the time, according to our best present knowl-

edge; but the process is especially active at the time of the milking, probably owing to the stimulus of the act of milking on the nervous system of the cow and the rapid emptying of the contents of the milk glands. When the milking begins, some of the milk is already elaborated; but the udder of a good dairy cow cannot hold more than a fraction of the milk yielded at a milking, when she is in full flow of milk, and the greater portion of the milk must, therefore, be formed during the process of milking from the material stored up in the aveoli during the interval since last milking.

FIRST AND LAST PORTIONS OF A MILKING.

The milk drawn at a milking is not of a uniform composition throughout, but that first given down is very low in butter-fat and of a similar composition as rather rich skim milk, while the last portions of the milk drawn are high in fat and at times resemble cream in composition. Many analyses are on record showing that the fat content of the first portion of a milking may be as low as 1 per cent., and that of the last drawn milk, generally known as strippings, 12 per cent. or more. We see, therefore, the wisdom of securing the whole mess of milk found in the udder at the time of milking. The losses which dairymen and cow keepers, in general, sustain from a failure to observe all desirable care in this direction, are most likely much larger than many appreciate, even men who are otherwise careful and painstaking in their work. We shall give definite information as to the amount of these losses in a later portion of this bulletin.

If the milking is done by the so-called stripping method, in which the teats are squeezed and pulled, the cow will gradually give up the last drop of milk in the udder; but the same end can be reached more readily and more completely by the method of milking to be explained presently. Besides being more effective and rapid, this method is not as hard on the cow and is less monotonous to the milker than is the stripping method.

ON THE IMPORTANCE OF THE WORK OF MILKING.

During late years, the subject of milking has received considerable attention in foreign dairy countries, and the importance of a thorough system of milking has been emphasized strongly by speakers and writers on dairy topics. Much evidence has also been brought forward bearing on this point. There are two ways in which the work of the milking may be looked upon: One way is to consider it a necessary burden, a work that has to be attended to, both because the cows must be relieved, and because the milk furnishes the raw material which may be readily turned into cash, and which the farmer, therefore, generally depends upon for defraying current expenses. Under such conditions, no particular attention is apt

to be given to regularity in the time or the order of milking the cows, and not overmuch thought is likely to be given to the thoroughness with which the work is done. The milking is often done when other farm work is out of the way, and no more attention than is absolutely necessary is given to the care and handling of the cows. This way of keeping cows is especially prevalent in regions where dairying is considered a rather unimportant side-issue, and where the farmers keep only a few cows, their main reliance being the production of cereal crops or stock-raising. Farmers of this class, like farmers in general in this country are often short of help and their help is likely to be averse to the work of milking. It is natural under these conditions, that the work which is considered least essential will be left to suffer first. Both because such farmers are numerous almost everywhere and because the number of cows kept by this class in the aggregate forms a very large proportion of the total cow population; this is a deplorable condition, since the production of the cows under such treatment is materially reduced, and a large loss to the dairy industry of the country is thus incurred.

The second way in which the work of milking may be looked upon, is to consider it an agency for improving the dairy qualities of the cows. It has been found by experience that cows that are always milked carefully clean will better keep up their flow of milk than is the case with cows milked in a careless manner, whose udders are not thoroughly emptied of milk at each milking, and that this flow will be maintained for a longer period of time. Careful milking, therefore, permanently improves the animal as a milk producer, aside from directly increasing the milk flow. Hence, the milking is done in a systematic, regular manner on farms where this view prevails, and at a definite hour set apart for the work, which is not deviated from except in case of absolute necessity, and particular attention is given to thoroughness of milking, so that no milk is allowed to remain in the udder at the conclusion of the milking.

The work of milking from this point of view is as important as any on the dairy farm, and nobody can do it properly but persons endowed with a good share of intelligence, patience and conscientiousness. It goes almost without saying that when the milker brings such qualifications to his work, it will be highly respected and its importance appreciated as it ought to be, by himself as well as by those about him.

The credit for having brought the subject of milking up for discussion of late years and for having emphasized its importance to the dairy interests, belongs to the Danish dairy instructor, Dr. J. Hegelund. of Ladelund Dairy School, Denmark. The dairy industry of that little country is of the highest national importance, and the Danes have left no stones unturned in their efforts to improve and

increase the production of their cows. The attention given to the subject of milking among them, through the special appointment of instructors who, by word and pen, are to work for better methods in this line, through the establishment of special courses of instruction in milking, and through publications on this subject, has been one of the striking features of dairy progress in that country during recent years. In a general way, the importance of the work of the milker has been known and appreciated long before the present age, but Dr. Hegelund was the first one among modern dairy teachers to bring the subject into prominence and to justify the attention which he bespoke for it; but he has done more—he has furnished proof that what is commonly called clean milking is not in many cases, or, even perhaps as a general rule, clean milking at all, and he has perfected a set of simple manipulations of the udder by which perfectly clean milking will always be assured. He has shown that a quantity of milk amounting to a couple of pounds per day, of the same character as strippings, may in many cases be secured by going through the set of maniplations after the regular milking is finished and the cows were supposed to have been milked dry, and this increase in production may often amount to more than 10 per cent., or more, of the total fat yielded.

It is the rich milk adhering to the cavities and ducts of the udder of the cow which is thus secured for the dairy; ordinary stripping, as previously suggested, will generally give similar results, but in point of efficiency and ease of execution, the manipulation method may be considered decidedly superior to the method of long-continued stripping and has none of its bad features.

THE HEGELUND METHOD OF MILKING.

The method of milking which Dr. Hegelund perfected and which bears his name, consists in following up ordinary rapid milking by certain manipulation of the udder which will bring down the residual milk in the udder after a full flow of milk has ceased. These manipulations are three in number, as shown below. It will be seen that the aim of the manipulations is, in general, to imitate a calf's way of getting the milk out of the udder. The following description of the Hegelund method of milking will explain its essential features, a fuller discussion of the same, and especially of the final and characteristic steps thereof, the manipulations of the udder, being deferred until the results of investigations in regard to the method have been presented. It will be noted that the important difference between this and any ordinary thorough method of milking lies in the manipulation part of the method, and for this reason the method is generally spoken of in this bulletin

as the manipulation method of milking. The description of the method given below follows quite closely that presented by the author in his report to the Royal Agricultural Society of Denmark in 1900.* The process of milking is separated into three steps, the main milking, the clean milking and the after-milking.

1. The milking is done with dry hands and with the whole hand, the two fore teats being milked first. The milking is begun by lifting the hands alternately with a pressure against the udder, the teats being held loosely with the hands. When considerable milk has come down, each hand is lowered until the teat has its natural length, without being stretched. As the hand is lowered, the teat is pressed from above downward with a gradually increasing pressure, and a continuous stream of milk is thus pressed out of the teat. At first, the milking is done slowly, taking care that the teat is not stretched; stretching will cause the cow to hold up her milk. When the milk flows readily, the milking is proceeded with as rapidly as the milker can possibly do it, until but very little milk is obtained. Interruption of the milking from the time the milk flows freely until the udder is emptied must be guarded against. As soon as a good flow of milk comes, the pressure against the udder mentioned above may be omitted. When only a thin stream of milk is obtained by this method of milking, the hand is again opened above, and while the lower fingers loosely hold the teats, thus remaining at the place most convenient for pressing the milk out of the teats, the hand is pressed against the udder, or its lower part is grasped so as to more easily secure a full stream of milk. When the fore teats do not give more milk, the hind teats are handled in the same way, but without beginning with the pressure against the udder, which is not necessary since the milk will now come down readily without this preliminary motion.

II. The hind teats being emptied, the "*clean milking*" is commenced. The fore teats are again grasped and the hands lifted to around the base of the fore quarters, taking hold of this, thumb on one side and the other fingers on the other. The milk is pressed into the milk cisterns by means of a light pressure, and from there out of the teats, thus emptying the fore quarters. In milking the hind quarters the hands grasp with each grip well up around the hind part of the quarters.

III. An "*after-milking*" now takes place, which is conducted in three different manipulations in the following manner:

First Manipulation.—The right quarters are pressed against each other (if the udder is very large, only one quarter is taken at a time), with the left hand on the hind quarter and the right hand on the

*Beretn. Landoekon Konsulentvirksomhed, 1900, pp. 31-39.

fore quarter, as shown in the illustration, Fig. 3a, the thumbs being placed on the outside of the udder and the four fingers in the divi-

FIG. 3a.—First Manipulation of Udder—Right-half.

sion between the two halves of the udder. The hands are now pressed toward each other and at the same time lifted toward the body of the cow. This pressing and lifting is repeated three times; the milk collected in the milk cisterns is then pressed out, and the manipulation repeated, until no more milk is obtained in this way, when the left quarters are treated in the same manner. (See Fig. 3b.)

FIG. 3b. First Manipulation of Udder—Left-half.

Second Manipulation.—The glands are pressed together from the side; the fore quarters are milked each by itself by placing one hand, with the fingers spread, on the outside of the quarter and

the other hand in the division between the fore quarters. The hands are pressed against each other and the teat then milked. (See Fig. 4a.) When no more milk is obtained by this manipulation, the

FIG. 4a. Second Manipulation of Udder—Right Forequarter.

hind quarters are milked by placing a hand on the outside of each quarter, likewise with fingers spread and turned upward, with the thumbs just in front on the hind quarters. The hands are lifted and grasp into the glands from behind and from the side, after which they are lowered to draw the milk. (See Fig. 4b.) The manipulation is repeated until no more milk is brought down.

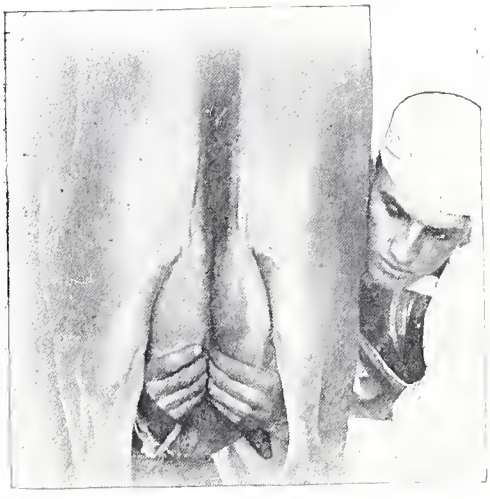

FIG. 4b. Second Manipulation of Udder—Hindquarters.

Third Manipulation.—The fore teats are grasped with partly closed hands and lifted with a push toward the body of the cow, both at the same time, by which method the glands are pressed between the hands and the body of the cow; the milk is drawn after

each three pushes. When the fore teats are emptied, the hind teats are milked in the same manner. (See Fig. 5.) The milking is then finished.

FIG. 5. Third Manipulation of Udder.

The writer first heard of this method of milking during a visit to the Scandinavian countries in the fall of 1901, and from the favorable reports received, decided to examine into the merits of the method as soon as opportunity offered after my return home. It was nearly toward midsummer of last year, however, before experiments in this line could be conducted; the results of the investigation then commenced, which were completed in the fall of 1902, with discussions of the method, were published in Bulletin No. 96 of the Wisconsin Experiment Station, entitled "Investigations of Methods of Milking" (Madison, Wis., Sept., 1902, 79 pp.). These results will be given in the main in the following pages, so as to enable the readers of this bulletin to draw their own conclusions concerning the value of the manipulation method of milking. We shall also give brief accounts of other work in regard to the method which has been published in the dairy or agricultural periodicals of this and other countries.

ACCOUNTS OF THE HEGELUND METHOD.

No authoritative full account of the Hegelund method has been published at this writing, although such an account was announced nearly a year ago. Pupils of Dr. Hegelund have, however, published pamphlets describing the method, as follows:

Chr. Worm, Den Hegelundske Malkemetode (The Hegelund Milking Method), Aarhus (Denmark,) 1902, 51 pp.

Leif Steen, Melkning efter Dyrläge Hegelunds Methode (Milking According to Dr. Hegelund's Method), Christiania (Norway), 1902, 18 pp.

Olof L. Danils, Om Mjölkning (On Milking), Stockholm, 1903, 48 pp.

Alois Alfonsus, Die zweckmäszigste Ausführung der Melkarbeit (The Best Method of Milking), Vienna, 1903, 33 pp.

Numerous descriptions and discussions of the method have furthermore been published in the European daily press. The first publication of the method in this country was, so fas as is known, made by the writer in the bulletin referred to above, and in Experiment Station Record, Vol. XIV, No. 3, pp. 286-287 (November, 1902). Through the former publication the knowledge of the method has been widely spread throughout this country, in different parts of Australia, as well as in England (strange to note, considering the fact that the method originated in Denmark), and in Germany. Our dairy and argricultural press have given a still wider publication of the method by reproducing the bulletin referred to in full in some cases, and in other cases by giving extracts of the essential parts of the bulletin, with illustrations of the manipulations recommended by the author.

THE IDEA OF THE METHOD NOT NEW.

It must not be understood that the Hegelund method is either new in principle or entirely original. It has long been known to some observing dairymen that the flow of milk from a cow may be increased by a slight manipulation of the udder, and such a method has been practiced in the quiet here and there in cases where a maximum production of milk and butter-fat from a cow has been a matter of considerable importance, as e. g., in competitive tests of cows. Fleischmann states, in his text-book on dairying,* that the milking is generally done in the mountain regions of Southern Germany with the pointer and the middle finger, with the assistance of the bent thumb, "and it is always made a point to press the udder gently between the hands several times not only before the milking, but also during the same."

Grotenfelt, in his "Principles of Modern Dairy Practice" (Amer. edition by F. W. Woll), gives a description of the proper method of milking, with dry, whole hands, stating that when only a little milk remains in the udder, this is given a couple of soft pushes and the milk pressed out as before.†

In the method of milking, which is sometimes spoken of with us as the Continental method, the Swiss method, or "thumb milking," and which is similar to that referred to by Fleischmann, the milking

*Lehrbuch d. Milchwirthschaft, 3d ed., p. 84.

†Loc. cit., third edition, p. 42.

is always preceded by some motions aimed to "let on" the milk. The teats of the cow and the sides of the udder are stroked with an easy downward motion and a squirt or two of milk is pressed out. This is continued until the teats swell, showing that the milk cisterns directly above the teats are full of milk, and the milking proper is then commenced. This preliminary handling is considered necessary in order to induce the cow to give down her milk readily and in full streams. Many a boy in the countries mentioned who could not yet milk has learned his first lessons in milking by being put to start in "letting down" in the manner stated on one cow, shortly before the regular milker was through milking the preceding one.

A similar method as that bearing the name of Dr. Hegelund has for a long time past been in use in Bohemia, among small farmers of that country, who keep only a cow or two or a few goats. These farmers are naturally anxious to obtain as high returns from their cows as possible, and to that end practice the following method: After the cows have been milked clean, the pail is put aside and the udder of the cow slapped with both flat hands from below upwards about a dozen times, and the milk is then drawn. From this practice the name "cow or goat slappers" (Kuhpritscher, Ziegenpritscher) has been given persons milking in this way.*

While the Hegelund method must, therefore, be considered a further adaptation and development of methods long known in dairy regions in the old world, from where it has reached us in single cases, great credit is, as previously stated, due to him for having systematized the manipulations and impressed upon the dairy world the importance of the work of the milker, as well as for having brought the manipulation method of milking to the general attention of the dairymen of Northern Europe and (indirectly) of this and other countries where dairying is an important industry.

Claims Made for the Hegelund Method.

The claims made for the Hegelund method refers, first, to the immediate increase of the production of milk and butter-fat by the cows, and, secondly, to the more lasting effects of the practice of exhaustive milking in maintaining a large flow of milk throughout the lactation period, in prolonging this, when necessary, until the cows are to be dried off, and in developing the dairy qualities of the cows and their offspring. The first claim may be readily established or refuted, and at the time when the writer began the experiments soon to be described, a number of accounts of brief experiments with a small number of cows had already been published, showing that an immediate increase of one to three pounds of

*Milchzeitung, 1902, p. 774; Alfonsus, loc. cit., p. 23.

milk per head and per day was generally obtained with different cows by the Hegelund method, over and above the yields obtained by the ordinary method of milking. It may be stated at this point that such yields of strippings, which the milk obtained by the manipulation method really is, correspond to at least two to six or eight pounds a day of milk of similar richness as the main portion of the milking.

In regard to the second point, it was stated, as a general proposition, mainly on theoretical grounds, without much direct evidence either for or against, that the practice would produce beneficial results, both as to the maintenance of the flow of milk through the whole period of lactation, and in gradually developing the cows as dairy animals. We shall give somewhat detailed accounts of early and later European experiments as to the immediate as well as the lasting and permanent influence of the manipulation method of milking, when the results conducted by the writer at the Wisconsin Experiment Station have been presented.

FIRST MILKING EXPERIMENT.

In the beginning of June, 1902, the writer conducted a brief preliminary milking experiment with the manipulation method, with the assistance of my colleague, Prof. W. L. Carlyle, cows in the dairy herd of the Wisconsin Experiment Station being used for the experiment. Each cow was milked clean, or supposed to be milked clean, by her regular milker, and the milking at once continued with the manipulation method by Prof. Carlyle. The two lots of milk were kept separately and both were weighed, sampled, and analyzed for their fat contents. The experiment was conducted with ten cows; four Shorthorns, three Holsteins, two Jerseys and one Guernsey cow.

The total results obtained with the different cows for two milkings are shown below:

Regular and Residual Milkings, June 3, P. M., and June 4, A. M.

Name of Cows.	Milk, Lbs.		Per Cent. Fat.		Fat, Lbs.		Total, Lbs.		Per Fat increased, per cent.
	Regular.	Residual.	Regular.	Residual.	Regular.	Residual.	Milk.	Fat.	
Belle,	22.4	3.45	3.48	7.0	.78	.24	25.85	1.02	30.8
Pauline,	23.5	3.55	3.53	7.6	.83	.27	27.05	1.10	32.5
June,	18.2	1.15	3.90	9.6	.71	.11	19.05	.82	15.5
Gold,	20.2	1.55	6.73	10.3	1.36	.16	21.75	1.52	11.8
Brownie,	13.4	1.25	5.45	8.0	.73	.10	14.65	.83	13.7
Campbell,	32.7	1.00	4.59	15.0	1.10	.15	33.70	1.25	13.6
Alma,	28.8	2.35	2.95	6.0	.85	.14	31.15	.99	16.5
Chloe,	27.8	2.95	3.67	9.1	1.02	.27	30.75	1.29	26.5
McGeoch,	44.5	1.70	3.42	8.8	1.52	.15	46.20	1.67	9.9
Dorine,	19.2	1.40	5.36	15.0	1.03	.21	20.60	1.24	20.4
Total,	250.7	20.35	.....	.....	9.93	1.80	271.05	11.73	.....
Average,	25.07	2.04	.....	.....	.99	.18	27.11	1.17	18.1
Average per cent. fat,	.....	.....	3.96	8.85	.....	.....	.....	4.33	.....
Average increase, in per cent.	.....	8.1	.....	.....	.....	18.1	.....	.....	.....

The percentages of fat given in the table are calculated from the sum of the amounts of milk and fat produced at the two milkings in case of the individual cows. It will be noted that a considerable increase of both milk and fat was obtained by the process of "after-milking;" the total yield of milk of 250.7 lbs. from the ten cows was increased by 20.35 lbs. (i. e., 8.1 per cent.), while the total production of fat from the cows was increased from 9.93 lbs. to 11.73 lbs. (i. e., 1.80 lbs. or 18.1 per cent.).

The cows gave down from 1.0 to 3.55 lbs. of milk by the manipulation method during the two milkings, after the regular milkers had secured their usual mess of milk. The amount of fat obtained in the after-milking ranged from .10 to .27 of a pound, or, calculating the gain in per cent. of fat in the regular milking, from 9.9 to 32.5 per cent.

Comparing the figures for the two milkings for the different cows, the following results will prove of interest:

	Evening.		Morning.	
	Milk.	Fat.	Milk.	Fat.
Regular milking, pounds,	130.1	5.09	120.6	4.84
After-milking, pounds,	10.20	.99	10.15	.81
Increase, per cent.,	7.8	19.5	8.4	17.4
Average per cow, after-milking, pound,	.51	.10	.48	.08

The total amount of milk in the evening milk obtained by manipulating the udders of the cows was 10.2 pounds (a gain of 7.8 per cent.), and that in the morning milking, 10.15 pounds (a gain of 8.4 per cent.) In the same manner the total production of fat by the ten cows was increased by 19.5 per cent in the evening milking, and by 17.4 per cent. in the morning milk.

The magnitude of these results was considerable of a surprise to us. The three regular milkers of the cows were supposed to be good milkers and to do their work well; they knew nothing about the purpose of the trial, but they could not help finding out before many cows had been milked, that their work was in some way being checked up. In spite of this fact, about the same increase in milk and fat was obtained for the different cows at the second milking as at the first one.

It may be said that the yields of these cows would be correspondingly decreased during the following day on account of the thorough emptying of the udders of the cows on the day of the experiment. But this is not the case. The milk record of the University herd shows that the ten cows on the day following the experiment yielded 260.7 pounds of milk in all, i. e., about ten pounds more than on the day of the experiment, seven cows giving more milk and three less. Separate tests of the milk of the cows were not made on this day.

Fifteen other cows in the herd which were milked in the ordinary way on both days gave the following yields: June 3d to 4th, 343 pounds; June 4th to 5th, 353.7 pounds, six cows going up in milk on the second day, eight going down and one giving the same amount both days. The change in the yield of milk with these cows, therefore, went in the same direction as with those on the trial, with some difference in favor of the cows that were after-milked. These facts fail to show that the extra careful emptying of the udders of the cows on the experiment had any tendency to reduce the amount of milk given by the cows on the following day. This question will be further considered when more data bearing on this point have been presented.

SECOND MILKING EXPERIMENT.

On account of the striking results obtained in this preliminary trial, it was decided to conduct a more extended experiment with cows in our University herd in order to decide the question whether or not the large increase obtained by the method of after-milking would gradually disappear when the method was practiced for a longer period; it is, of course, entirely feasible that the cows might at first readily respond to this treatment and later on gradually accommodate themselves to the same so that no marked results would be obtained by after-milking.

The plan of the second experiment was as follows: Three lots of cows of eight each, as uniform as possible to period of lactation, age, breed, production of milk and butter-fat, etc., were arranged for.

Lot I was after-milked during the first and fourth weeks of the experiment.

Lot II was after-milked during the second and fifth weeks.

Lot III was after-milked every other day during the first two weeks and the last two weeks.

During the third week the cows in Lot I were "stripped" for three minutes after the regular milkings were finished, while Lot II was treated in the same way every other day. The object of introducing this trial was to compare the systematized manipulation method with simple stripping for a similar length of time.

The names of the cows included on the experiment are given in the following table, with information in regard to these which has a bearing on this experiment.

Description of Cows on Experiment.

Lot.	Name.	Breed.	Age.	In milk, June 10.	Due to calve.	Yield, June 4-11.		Per cent. fat.	Milker.
						Milk.	Fat.		
			Years.	Days.	Days.	Lbs.	Lbs.		
I	Mollie,	Gr. Shorthorn,	3	200	271	165.1	5.61	3.4	I
	Belle,	Gr. Shorthorn,	8	73	287	165;2	5.45	3.3	I
	Mary,	Guernsey,	2	137	284	91.7	4.40	4.8	I
	McGeoch,	Gr. Holstein,	5	119	248	338.8	10.17	3.0	II
	Alma,	Holstein,	6	290	195	206.9	6.08	2.95	II
	Rilma,	Gr. Jersey,	3	83	308	147.7	7.68	5.2	II
	Dora,	Gr. Guernsey,	7	156	276	184.5	9.04	4.9	III
	Laura,*	Jersey,	7	500	57	95.5	4.97	5.2	III
II	Princess,	Gr. Shorthorn,	4	218	182	134.3	5.38	4.0	III
	Pauline,	Gr. Shorthorn,	8	191	208	170.2	6.21	3.65	II
	Chloe,	Holstein,	6	270	176	218.1	7.20	3.3	I
	Lady,	Gr. Red Polled,	6	307	123	192.1	7.49	3.9	II
	Dorine,	Gr. Guernsey,	3	148	268	141.7	6.94	4.9	I
	Ella,	Gr. Guernsey,	9	86	272	236.3	10.63	4.5	III
	Brownie,	Jersey,	5	270	208	108.4	5.90	5.45	III
	Elsie,	Gr. Jersey,	3	106	272	128.6	6.23	4.85	I
III	Maud,	Gr. Shorthorn,	8	192	227	236.5	8.75	3.7	II
	June,	Gr. Shorthorn,	3	269	200	139.8	5.10	3.65	I
	Joe,	Holstein,	3	308	149	186.0	6.14	3 3	II
	Donation,	Gr. Holstein,	6	163	198	212.5	6.80	3 2	III
	Bessie,	Gr. Guernsey,	10	288	126	153.2	7.05	4.6	III
	Muriel,	Gr. Guernsey,	3	84	292	145.6	8.30	5.7	I
	Gold,	Jersey,	10	270	288	148.3	9.34	6.3	II
	Reba,	Gr. Jersey,	5	105	252	199.1	9.96	5 0	III

*Dixie (substituted for Laura after 3d week) is a grade Shorthorn, age 3 years, 146 days in milk (on June 10), due to calve in 137 days; milk, 110.4 pounds; fat, 4.42 pounds; 4.0 per cent. fat.

The milking of the cows was done in the following manner: As soon as the regular milker had milked a cow clean, the herdsman sat down to after-milk her; both lots of milk were at once weighed and sampled. In a few cases, there was a delay of a minute or two before the after-milking could begin, but so far as could be observed, the lapse of an interval of a few minutes did not have any tendency to give an increased quantity of milk in the after-milking. During the last three weeks of the experiment composite samples of the regular milk and after-milkings from each cow were taken, instead of separate samples.

The production by the different lots of cows for each week of the experiment is given in the following summary table. The data for production of milk and fat placed in the columns headed "*Regular Milking*," were obtained during the weeks (*days* for Lot II) when the cows were not after-milked, if there are no figures on the same line in the columns headed "*Residual Milking.*" The data obtained when after-milking was practiced are shown in the table for each week (total for alternate days, in case of Lot II), the quantities of milk secured in the regular milking and the after-milking being given separately.

Summary of Results Obtained on Second Milking Experiment.

Lot.	Week.	Regular Milking.			Residual Milking.			Total.		
		Milk.	Fat.	Fat.	Milk.	Fat.	Fat.	Milk.	Fat.	Fat.
		Lbs.	Lbs.	Per ct.	Lbs.	Lbs.	Per ct.	Lbs.	Lbs.	Per ct.
I,	1	1,386.6	53.94	3.89	67.55	4.92	9.1	1,454.15	58.86	4.05
	2	1,377.8	53.76	3.90	.....	.....	.....	1,377.8	53.76	3.90
	4	1,100.4	43.98	4.00	50.55	3.94	7.79	1,150.95	47.92	4.16
	5	1,170.6	46.82	4.00	.....	.....	.....	1,170.6	46.82	4.00
II,	1 & 2	1,313.2	54.06	4.12	.....	.....	.....	1,313.2	54.06	4.12
		1,303.8	54.23	4.16	57.95	5.53	9.54	1,361.75	59.76	4.39
	4 & 5	1,081.1	46.43	4.29	.....	.....	.....	1,081.1	46.43	4.29
		1,084.5	46.45	4.28	52.65	4.80	9.11	1,137.15	51.25	4.51
III,	1	1,424.1	60.15	4.07	.....	.....	.....	1,424.1	60.15	4.07
	2	1,396.9	58.10	4.16	61.45	5.25	8.54	1,458.35	63.35	4.34
	4	1,199.3	51.64	4.30	.....	.....	.....	1,199.3	51.64	4.30
	5	1,220.3	52.29	4.29	48.65	4.08	8.38	1,270.75	56.37	4.41
Total,	1 & 2	4,115.1	167.97	4.08	.....	.....	.....	4,115.1	167.97	4.08
		4,087.3	166.27	4.07	186.95	15.70	8.40	4,274.25	181.97	4.26
	4 & 5	3,451.0	144.89	4.20	.....	.....	.....	3,451.0	144.89	4.20
		3,405.2	142.72	4.19	151.85	12.82	8.45	3,558.85	155.54	4.37
	1-5	7,566.1	312.86	4.14	.....	.....	.....	7,566.1	312.86	4.14
		7,492.9	308.99	4.12	338.8	28.52	8.42	7,833.1	337.51	4.31

On account of the advanced stage of the lactation period of several cows, the decrease in the production of milk and fat was more marked than would otherwise have been the case; the time of the year also introduced several disturbing factors; *first*, because the weather conditions were subject to great fluctuations

and as the cows were outdoors most of the time they were more dependent upon the weather than in winter time, and, *second*, because it was impossible to secure a uniform system of feeding throughout the experiment. The cows had to be changed repeatedly from a luxuriant oat pasture to an upland blue-grass pasture and from this again to a lowland pasture, according to the supply of food or the weather conditions. The disturbing influence of the conditions mentioned is plainly shown by the milk records for the whole herd (including the cows on the experiment) during the different weeks the experiment was in progress. The total production of milk by all cows in milk at this time was as follows:

Milk Produced by Whole Herd, June 11—July 16.

	Week of experiment.	Total milk produced.	Number of cows in milk.	Average per head daily.
		Lbs.		Lbs.
June 11-18,	1	4,828.1	29	23.7
June 18-25,	2	5,265.5	29	25.9
June 25-July 2,	3	4,470.8	29	22.0
July 2-9,	4	3,997.2	28	20.3
July 9-16,	5	4,228.4	28	21.6

We shall not here discuss the causes of the fluctuations shown in the preceding table since they are of minor importance in this connection, the main object being to study the influence of the method of after-milking upon the normal production of milk and fat from the cow.

The figures given in the last table but one permit of the following deductions:

1. As to the total production of the cows.

Considering first the *regular milking*, we note that there is only a slight difference in the production of milk and butter-fat for periods when after-milking was *not* practiced, and when it was. The total amount of milk produced by the ordinary method of milking, when the cows were not after-milked, was 7,566.1 pounds, and when they were after-milked, 7,492.9 pounds, a difference of less than 1 per cent. A similar difference occurs in the production of fat during the different periods. As the influence of the advance of the lactation period was eliminated so far as possible in planning the experiment, we are justified in concluding that the thorough emptying of the udders of the cows during the days these were after-milked did not reduce the milk yields of the cows

on days when only ordinary milking was practiced; we should otherwise have had a smaller yield in the latter case than from regular milking alone in the former. This is especially plain when the records for Lot II are studied; in this case the cows were after-milked every other day, and milked only by the regular method on the intervening days. If taking out every drop of milk in the udder, e. g., to-day, by the method of after-milking, will tend to decrease the flow of milk to-morrow, the yield then obtained should be less than the regular milking of to-day; when we consider the totals for four weeks we find that such is not the case; on the other hand, there is evidence of a stimulating effect in the manipulation method, when the total results for Lot II and those for weeks 1 and 2 of the experiment are considered, while in case of the last two weeks there is a very slight deficit of 3.4 pounds on 1,084.5 pounds (.3 per cent.), for the days when only regular milking was practiced. Considering the yields from individual cows, we find an increase in seven instances and a decrease in nine instances; the total amounts in the former cases are, however, larger than in the latter. The difference in yields of milk and of fat as well as per cent. of fat in the udder on regular milking with or without subsequent after-milking, are small and may not signify much, but it is readily seen that the results cannot be interpreted as showing any depressing influence of the process of after-milking, on the production of milk and butter-fat during periods following the after-milking.

What ever be the interpretation of the results for regular-milking days and after-milking days, the figures given in the table show that the yields obtained by the process of after-milking are essentially clear gain, so far as production alone is concerned. We shall later on discuss whether or not this increase is obtained at an extra cost.

2. As to the amount of milk and butter-fat in the after-milking.

On the average for all three lots of cows the yield of milk was increased by 338.8 pounds (*4.5 per cent.*) by the process of after-milking, and that of butter-fat by 28.52 pounds (*9.2 per cent.*). The increase in milk was 4.6 per cent. during weeks 1 and 2, and 4.5 per cent. during weeks four and five; that of fat, 9.4 and 9.0 per cent., respectively.

The slightly lower gains obtained in the after-milking during weeks 3 and 4 of the experiment are in all probability explained by two facts: *First*, the herdsman did not go through the complete manipulations with all the cows during this time, as was the case during weeks 1 and 2, but only continued the manipulations so long as an appreciable stream of milk was obtained, so that in case of some cows which did not give down

much milk on, e. g., the first manipulation, this was only made once and the other two manipulations three times, if necessary; he also made much lighter work of the manipulations during these weeks than in the beginning, since this had proved almost equally efficient in bringing down the last traces of milk in the udder. *Second*, the regular milkers milked somewhat cleaner during the latter part of the experiment, especially milkers I and II, having found out in a general way from the results obtained during the first two weeks that their work was not done as carefully as might be expected.

AVERAGE GAIN IN MILK AND BUTTER PRODUCTION.

The average amount of milk per day and per cow obtained by the manipulation method over and above that obtained by the regular milkers was a little over one pound, and the amount of butter-fat 0.09 pound. The results for the different cows varied considerably, as will be especially apparent if the percentage figures are considered instead of the absolute figures for gain in the production of milk and butter-fat. The increase in the production of fat obtained by the manipulation method, calculated in per cent. of the total production of the cows, was, as a rule, quite constant for each cow throughout the experiment, but with the different cows the gain in fat varied from less than 5 per cent. to about 30 per cent., on the average, for the whole experiment. Low results were obtained with the following cows:

Maud, 3.0 per cent.; Donation, 4.0 per cent.; McGeoch, 4.2 per cent.; Laura, 4.2 per cent.; Dora, 4.5 per cent.; Pauline, 5.3 per cent.; Dixie, 5.6 per cent., and Ella, 7.1 per cent.

High results were, on the other hand, obtained with the following cows:

Mary, 30.2 per cent.; Elsie, 16.9 per cent.; Bessie, 14.3 per cent.; Muriel, 14.2 per cent.; Dorine, 13.3 per cent.; Belle, 12.4 per cent., and Lady, 11.2 per cent.

The former cows include among their number three Shorthorns, two Holsteins, two Guernseys and one Jersey; among the latter cows are one Shorthorn, four Guernseys, two Jerseys and one Red Poll. The breed has evidently nothing to do with the gain obtained in after-milking, neither does the conformation of the udder seem to be much of a guide as to the amount of milk obtained in the after-milking. Since most of the cows tested by us were not milked perfectly clean by the regular milkers, the data obtained as to the exact amounts brought down by the manipulation method alone are hardly sufficient to permit of definite conclusions as to the relation of the shape or the quality of the udder to the amount of residual milk obtained.

It becomes quite apparent, in studying the data obtained on this experiment, that the variations in the increase in the production of milk and butter-fat which was secured by the manipulation method, were due largely to the character of the work done by the different regular milkers. The cows giving the lowest gains in the production of butter-fat were milked as follows: Three by milker No. II and five by milker No. III; of those giving the highest gain, five were milked by No. I, two by No. II and one by No. III. We shall discuss further the work done by the different milkers in these experiments when the evidence as to the value of the manipulation method obtained at a number of different dairy farms has been presented.

SUMMARY OF RESULTS OF MILKING EXPERIMENTS AT WISCONSIN EXPERIMENT STATION.

1. Preliminary Trial.—Ten cows of four different breeds were milked by the manipulation method according to Dr. Hegelund; the yield of milk was increased by 8.1 per cent. as the mean of two milkings, and the yield of fat was increased by 18.1 per cent. over and above the usual production obtained by the ordinary method of milking. The increase in the production of fat ranged from 9.9 per cent. to 32.5 per cent., in case of the individual cows.

2. Main Experiment.—Twenty-four cows belonging to five different breeds were milked by the manipulation method during alternate weeks (Lots I and III) or alternate days (Lot II) for a period of four weeks; the average daily production of milk by the cows during this time was increased by 4.5 per cent. by means of the manipulation method, and the average production of fat was increased by 9.2 per cent., there being a range in the percentage gains in fat for the single cows of from 3.0 to 30.2 per cent. The average gain in milk for the whole period was one pound and in fat nine-hundredths (or nearly one-tenth) of a pound per head per day.

FURTHER EXPERIMENTS AS TO THE VALUE OF THE MANIPULATION METHOD.

The results of the experiments just described were considered very promising and, to a large extent, sustain the claims made as to the value of the manipulation method of milking. The weak point in drawing definite general conclusions from these results is, however, that the experiments were conducted with dairy cows in one herd only, where the conditions as to the care and handling of the cows are uniform and, generally considered, exceptionally good. We were certainly, up to the time of these experiments, of the

opinion that the character of the work of milking done in this herd was beyond criticism. In order to secure further data as to the value of the new method of milking, with cows kept under different conditions, and as to the character of the milking done at different dairy farms, it was decided to extend the investigation to a number of dairy farms in Central and Eastern Wisconsin, and to determine the amounts of milk obtained by the manipulation method in each case, as well as the average percentage increase in the production of fat by the different cows. Ordinarily, about ten cows were tested in each herd, the cows being after-milked by my assistant immediately after the regular milking was finished or, at most, within a minute or two thereafter. Before the various manipulations of the udder were practiced, and the residual milk drawn, the cows were milked perfectly clean by my assistant by the ordinary method of milking, if the regular milker had not already done it. A note was always made (during the later trials, at least) when some milk was obtained by us by the ordinary method of milking, so that we are able to tell whether the milking was clean in case of any particular milker.

Twenty-four hour tests were made on the first trials, while later on it was decided to extend each trial to cover three consecutive milkings, so as to be able to compare the third milking with the first one, these being made at the same time of the day. The purpose of lengthening the trial to include three milkings is easily seen; if a large amount of milk is obtained by the manipulations, the thought at once suggests itself that the next milking or milkings will be correspondingly decreased. The data obtained on the two experiments just described fail to show that such a view is correct, but since there seems to be a prevalent belief to this effect among dairymen and farmers, it was deemed desirable to secure more evidence on this point.

The weighings and the testing of both the regular milk and the after-milk were always done by me or my assistant; the regular milking was done by the farmer himself or the farm hands, who usually milked the cows. The effort was made in each case to cause as little deviation from ordinary every-day conditions as possible. It may be in order to state that where the milker was at all jealous of his reputation, as all good milkers would be and some poor ones might be, the results obtained by the manipulation method have a tendency to be lower than they would have been, could the after-milking have been done without their being forewarned, by bringing into the stable the paraphernalia of weighing and testing, that their work was going to be checked up in some way. The data secured on the farms visited and given in the

following, therefore, doubtless show the minimum *immediate* results obtained by practicing the manipulation method; they do not furnish evidence as to the effect on the cows, or on their yields of milk or fat, of practicing the method for any length of time.

The results obtained at any one farm were not generally made known to the owner or the milkers until the trial was over, so as to secure, so far as possible, every-day results as to the character of the milking. In this we were only partly successful, however, as the curiosity of the milker as to whether we "got something" from his cows, or how much we got, often had to be satisfied, at least in a general way; hence, the work of milking was at times done better after the first milking than at this milking. With a good many milkers no curiosity was shown as to our findings, and the magnitude of these, or their importance, was often not appreciated, even where the loss sustained through careless milking was very large. One milker who left over two pounds of residual milk in the udder at a milking said, "Why, you did get a little something, didn't you?" and another wanted to know if he "hadn't better leave a little so as to give us enough for a sample." This milker left from one to three pounds of milk a day in the udder of a cow, and over a pound of butter-fat from eight cows; in the case of one cow even .31 of a pound for the day; this is about half of the total daily production of a fairly good dairy cow. The large per cent. of butter fat contained in the after-milk, which amounts to at least twice that of ordinary milk and often more than three times, was rarely appreciated by the milkers with whom we were brought in contact in these trials, nor would they be apt to be appreciated by most farmers who have not seen tests made of such milk or observed the proportion of cream formed on it on standing.

DAIRY FARMS VISITED.

The twelve farms where these trials were conducted represent different classes of farming, farms where only a small number of cows are kept, which are all milked by the owner himself, or the owner and his wife; specialized dairy farms where the owner himself milks some of the cows kept; farms where the cows are kept primarily for breeding purposes and only secondarily for the production of dairy products, and, finally, dairy farms owned by city people who do not depend on farming for a living and do not have personal charge of the management of their farms, or take part in the milking. One class of farmers are not represented in the trials, viz., general farmers, who keep only a few cows, not to exceed ten, perhaps, and who in no way are specialized dairymen, nor give the cows any more care or attention than they absolutely

require. Several unsuccessful efforts were made to induce some farmers of this class to allow us to conduct tests of their cows by the manipulation method and incidentally look into the manner in which the milking was done in their herds; one farmer did not have time to "fuss and experiment;" another thought "it of no use to conduct the tests with their cows, for even if the method proved to be a good thing they would not have time to use it;" with many farmers of this class, which is, unfortunately, numerous, especially outside of dairy regions, the general farm work takes up nearly the whole time of owner and farm hands, and the cows get what is left.

It would doubtless have been possible to find a number of such farmers without going very far from Madison, who would have consented to have the tests made, as a matter of courtesy, but as the results with herds owned by farmers who took a personal interest in their cows came surprisingly high, in some cases showing an average increase of about twenty per cent. in the production of fat from the cows by the manipulation method, no further efforts were made to have the work done with herds of small general farmers, as it was believed that the results which these would furnish could at all events not be lower and were likely to come still higher; hence, the lesson which the trials teach is applicable to these as well as to wide-awake, progressive farmers, whose cows were tested and who had not previously had their attention called to the importance of thorough conscientious milking.

The time of the year when these tests were made was unfavorable for making a good showing for the herds, since a majority of the cows tested were well along in milk. Quite a number of cows that were only a few months from calving are, however, included among those tested, and several representatives of cows just coming in are found both among these herds and the University herd. A brief description of the system of farming adopted in case of the different farms is given in the following. The result per cow for the 24-hour tests are given below under each herd, as regards regular and residual milkings, also the total production and average fat content of the milk, and the percentage increase in the fat production of the cows for the day over and above that yielded in the regular milkings.

All the farms visited are located within the State of Wisconsin. They are given in the order in which the tests were made.

TEST OF HERD No. I.

A herd of pure-bred Guernsey cattle, eighteen cows in the herd, of which eleven were tested. The product from the cows is sold as separator cream. A milk record is kept, giving the weight of each

milking from individual cows, and tests of the milk from single cows are made once a month from two- or three-day composite samples. The stable is neat and clean, well lighted and ventilated. The cows are fastened by chains attached to moveable horizontal bars. They were milked by the owner and one hired man, the last four cows given in the table being milked by the latter. The milking was thorough in all cases. The owner has a reputation second to none in the State as a breeder of Guernseys and as a progressive dairyman.

Results of Tests of Cows in Herd No. I.

Number.	Yield Per Day.				Total milk.	Total fat.	Average per cent. fat.	Increase in fat.
	Milk.		Fat.					
	Regular.	Residual.	Regular.	Residual.				
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.		Per ct.
1,	26.4	.25	1.25	.03	26.65	1.28	4.79	2.4
2,	17.4	.55	.76	.08	17.95	.84	4.67	10.5
3,	27.5	.65	1.28	.09	28.15	1.37	4.86	7.0
4,	30.4	1.35	1.42	.13	31.75	1.55	4.87	9.2
5,	22.5	.25	.93	.02	22.75	.95	4.17	2.2
6,	18.1	1.55	1.03	.23	19.65	1.26	6.40	22.3
7,	25.7	.70	1.14	.09	26.4	1.23	4.66	7.9
8,	23.5	.55	.96	.05	24.05	1.01	4.19	5.2
9,	24.0	.30	1.23	.04	24.3	1.27	5.23	3.3
10,	25.7	.95	1.25	.10	26.95	1.35	5.06	8.0
11,	13.2	1.10	.72	.11	14.3	.83	5.80	15.3
Average yields,	23.1	.75	1.09	.09	23.85	1.18	.....	.....
Average per cent. fat,	4.71	11.83	.....	.....	.....	.....	4.92	.....
Gain in per cent.,	.....	**3.2**	.....	**8.1**	.....	.....	.....	.....

Average gain in fat by after-milking, P. M., 7.3 per cent.; A. M., 9.1 per cent.

TEST OF HERD No. II.

A herd of pure-bred Holstein-Friesian cattle, twenty cows in the herd, ten of which were tested. The milk product is delivered at a neighboring cheese factory, and paid for according to the weight delivered. The milk from individual cows is weighed every third day, and tested once a month from two-day composite samples. The cows are kept in a basement stable, and are fastened by Newton ties. They are milked by the owner and two hired men: Nos. 1-5 by the owner, Nos. 6-8 by the herdsman and Nos. 9-10 by a farm hand. The milking was clean in case of all cows except No. 5. The cows were milked three times a day, except No. 1, which was milked twice a day. The herd is well known among breeders and admirers of Holstein-Friesian cattle as the home of the Johanna family. Although the owner had no previous knowledge of our

coming to the farm to conduct a test and could not, therefore, have prepared for the test, even if he had wanted to, and although the cows were well along in their lactation periods, the average production of fat from the ten cows for twenty-four hours was 1.80 pounds, two of the cows producing 2.5 pound of butter-fat and two others 1.99 and 1.84 pounds. The cows were fed corn silage and a little wheat bran, with run of blue-grass pasture day and night- except at milking time.

Results of Tests of Cows in Herd No. II.

Number.	Yield Per Day.				Total milk.	Total fat.	Average per cent. fat.	Increase in fat.
	Milk.		Fat.					
	Regular.	Residual.	Regular.	Residual.				
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.		Per ct.
1,	39.4	.95	1.32	.09	40.35	1.41	3.49	6.8
2,	47.3	1.25	1.62	.09	48.55	1.71	3.52	5.6
3,	50.6	1.00	1.58	.06	51.6	1.64	3.18	3.8
4,	49.4	3.50	1.55	.29	52.9	1.84	3.48	18.7
5,	69.5	1.10	2.39	.09	70.6	2.48	3.51	3.8
6,	39.9	3.90	1.44	.23	43.8	1.67	3.81	16.0
7,	42.9	.65	1.50	.05	43.55	1.55	3.56	3.3
8,	66.4	.80	2.46	.07	67.2	2.53	3.76	2.9
9,	31.2	.50	1.10	.03	31.7	1.13	3.56	2.7
10,	53.1	4.25	1.61	.38	57.35	1.99	3.47	23.6
Average yields,	49.0	1.79	1.66	.14	50.8	1.80	.....	.....
Average per cent. fat,	3.38	7.71	.....	.....	.....	.....	3.53	.....
Gain in per cent.,	.....	**3.7**	.....	**8.3**	.....	.....	.....	.....

Gain in fat: Evening, 7.7 per cent.; morning, 10.8 per cent.; noon (9 cows), 6.6 per cent.

Cow No. 10 gave down a quarter of a pound of milk by the manipulation method on the evening of June 26, after the regular milking was finished, 3.50 pounds the following morning, and half a pound at noon, making 4.25 pounds in all for 24 hours. The farm hand who milked the cow is a good milker; he thought that he had milked the cow clean in the morning, but she evidently held up her milk toward the end of the milking and was only induced to give down more after the first manipulations had been gone through with, when milk again flowed freely for several minutes. The other cows that yielded considerable quanities of milk in the after-milking gave down about a third of the total quantities at each milking.

As the secretion of milk goes on all the time in the udder, it might be argued that the milk obtained in the after-milking is only what is elaborated while the manipulations are being practiced. Such is not the case, however. Taking the maximum daily yield of milk obtained from any cow on this investigation, 70.6 pounds (No. 5 in

the preceding table), we note that if the secretion was equally distributed during the twenty-four hours, this cow would produce 2.94 pounds per hour, and .45 of a pound for three times three minutes, which would be the longest time the manipulation method would take with a good milker. The cow referred to gave 1.1 pounds in the after-milking and none of the other cows, which yielded considerably less total milk, gave less than .5 pounds of after-milk for the day. For a cow yielding 30 pounds of milk per day, the amount of milk secreted during six minutes would be .13 of a pound and during nine minutes, .19 of a pound.

TEST OF HERD No. III.

A herd of pure-bred Jersey cattle, twenty-seven cows in the herd, of which twelve were tested. The milk is separated at the farm and the cream shipped to Milwaukee. The milk from each cow is weighed at every milking and tested once a month from composite samples of four milkings. The cows stand in Drown stalls, in a well-lighted, well-ventilated and neatly kept stable. The milking is done by four milkers, the owner (I), and his son (II), the herdsman (III), and a farm hand (IV). The cows were milked clean in all cases except cow No. 10, June 27, P. M. This herd, like the two preceding ones, is one of the foremost of the breed in the State; the owner enjoys an enviable reputation as a dairyman and as a careful breeder of Jersey cattle.

Results of Tests of Cows in Herd No. III.

Number.	Milker number.	Yield Per Day.				Total milk.	Total fat.	Average per cent. fat.	Increase in fat.
		Milk.		Fat.					
		Regular.	Residual.	Regular.	Residual.				
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.		Per ct.
1	I	36.1	1.30	1.50	.17	37.4	1.67	4.47	11.3
2	IV	38.5	.55	1.84	.07	39.05	1.91	4.88	3.8
3	I	41.1	.25	2.05	.04	41.37	2.09	5.05	2.0
4	IV	32.1	.35	2.08	.05	32.45	2.13	6.55	2.4
5	IV	35.0	.55	1.93	.07	35.55	2.00	5.62	3.6
6	I	28.2	.20	1.33	.02	28.4	1.35	4.75	1.5
7	I	29.7	.50	1.77	.08	30.2	1.85	6.13	4.5
8	II	11.0	.65	.69	.07	11.65	.76	6.50	10.1
9	I	36.3	.35	1.33	.04	36.65	1.37	3.73	3.0
10	III	32.5	.95	1.48	.10	33.45	1.58	4.72	6.8
11	II	26.0	.40	1.34	.05	26.4	1.39	5.27	3.7
12	IV	27.6	.50	1.64	.07	28.1	1.71	6.09	4.3
Average yields,		31.2	.55	1.58	.07	31.75	1.65		
Average per cent. fat,		5.08	12.68					5.20	
Gain, per cent.,			**1.8**		**4.4**				

Average gain in fat: Evening, 7.4 per cent.; morning, 4.0 per cent.

The total yield of milk from the cows on June 26, P. M., was 188.4 pounds; on July 27, P. M. (the day of the trial), 193.2 pounds (with 3.6 pounds in the after-milk), and on June 28, P. M., 183.3 pounds. Ten cows gave less and two cows more milk on the evening of June 28, than on the evening of June 27. Eight other cows in the herd yielded the following amounts at the three milkings given: 82.6 pounds, 80.0 pounds and 81.5 pounds.

TEST OF HERD No. IV.

The herd of a general farmer. Eight cows in the herd, all of which were tested. The milk from the herd is sold to a hotel in the city. No records are kept of the yield of milk from the cows, nor are tests of the milk made; the cows are kept in a dark stable in stanchions, at the time of test only during milking, the rest of the day in pasture. The milking was done by the owner and was, as a rule, clean.

Results of Tests of Cows in Herd No. IV.

Number.	Yield Per Day.				Total milk.	Total fat.	Average per cent. fat.	Increase in fat.
	Milk.		Fat.					
	Regular.	Residual.	Regular.	Residual.				
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.		Per ct.
1,	33.8	.55	1.55	.07	34.35	1.62	4.72	4.5
2,	31.5	1.35	1.40	.18	32.85	1.58	4.81	12.9
3,	28.1	.50	1.27	.05	28.6	1.32	4.62	3.9
4,	14.6	1.45	.89	.12	16.05	1.01	6.31	13.5
5,	16.3	1.10	.88	.14	17.4	1.02	5.86	15.9
6,	27.5	.50	.96	.04	28.0	1.00	3.57	4.2
7,	27.9	.40	.92	.04	28.3	.96	3.39	4.3
8,	24.0	.25	.90	.02	24.25	.92	3.79	2.2
Average yields,	25.5	.76	1.10	.08	26.36	1.18	.....	.....
Average per cent. fat,	4.31	10.81	.....	.....	.....	.....	4.49	.....
Gain, per cent.,	.....	**3.0**	.....	**7.5**	.....	.....	.....	.....

Gain in fat: Evening, 7.5 per cent.; morning, 7.5 per cent.

The total yield of milk from the eight cows on July 23, P. M. (the day of the trial), was 111.1 pounds (and 3.15 pounds of after-milk), and on July 24, P. M., 113.6 pounds, four cows giving more and four cows giving less at the latter milking than on the evening of the trial day. The production of fat was lower for all the cows on July 24, P. M., than on the corresponding milking of the trial day, although, as a rule, only slightly so.

TEST OF HERD No. V.

The herd of a general farmer; seventeen cows in the herd, eight of which were tested. The milk is sold to a milk dealer. No record is kept of the weight of milk produced by the cows, and its quality is not determined. The cows are kept in a basement stable in Bidwell stalls, rather dark, but fairly well ventilated. The cows tested were milked by the owner, the milking being clean in all cases.

Results of Tests of Cows in Herd No. V.

Number.	Yield Per Day.				Total milk.	Total fat.	Average per cent. fat.	Increase in fat.
	Milk.		Fat.					
	Regular.	Residual.	Regular.	Residual.				
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.		Per ct.
1,	12.5	.70	.51	.06	13.2	.57	4.31	11.8
2,	20.5	.45	1.32	.05	20.95	1.57	5.24	3.8
3,	19.3	.80	.87	.09	20.1	.96	4.77	10.3
4,	20.3	.65	.79	.06	20.95	.85	4.06	7.6
5,	16.5	.50	.84	.06	17.0	.90	5.30	7.1
6,	6.7	.40	.40	.05	7.1	.45	6.34	12.5
7,	18.4	.80	.66	.08	19.2	.74	3.85	12.1
8,	25.8	.55	1.30	.08	26.35	1.38	5.24	6.2
Average yields,	18.6	.61	.83	.07	19.2	.90	.....	.....
Average per cent. fat,	4.49	10.93	.....	.....	.....	.....	4.69	.....
Gain, per cent.,	.....	**3.3**	.....	**7.9**	.....	.....	.....	.....

Gain in fat: Morning, 6.4 per cent.; evening, 9.7 per cent.

The total yield of milk and of fat came as follows: First milking, 74.1 pounds of milk (and 2.15 pounds of after-milk), and 3.59 pounds of fat; third milking, 66.6 pounds of milk and 2.97 pounds of fat: all the cows giving less milk and all but one less fat on the third milking than on the first one.

TEST OF HERD NO. VI.

A "Model Dairy Farm" (so-called); thirty cows in the herd, of which number fifteen were tested. The milk from the herd is pasteurized and retailed in the city. No records are kept of the weights or the quality of the milk produced by the single cows. The cows stand in Bidwell stalls, in a well-lighted and well-ventilated stable. At the time of the test they were kept in the stable during milking only. Feed, green fodder corn and pasture. The

milking was done by four hired men, of whom only one milked clean. Only indefinite information concerning the age and last calving time of the different cows could be obtained.

Results of Tests of Cows in Herd No. VI.

Number.	Milker number.	Yield Per Day.				Total milk.	Total fat.	Average per cent. fat.	Increase in fat.
		Milk.		Fat.					
		Regular.	Residual.	Regular.	Residual.				
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.		Per ct.
1,	II	19.4	.90	.59	.05	20.3	.64	3.15	8.5
2,	III	29.0	.90	1.08	.09	29.9	1.17	3.94	8.3
3,	II	26.8	.55	.91	.04	27.35	.95	3.47	4.4
4,	I	13.4	3.20	.64	.24	16.6	.88	5.30	37.5
5,	II	13.4	.45	.77	.07	13.85	.84	6.06	9.1
6,	I	27.4	2.05	.88	.13	29.45	1.01	3.43	14.8
7,	III	16.3	1.60	.97	.14	17.9	1.11	6.20	14.4
8,	IV	15.1	2.95	.78	.25	18.05	1.03	5.71	32.1
9,	I	12.8	1.90	.75	.21	14.7	.96	6.53	28.0
10,	IV	9.7	.45	.60	.06	10.15	.66	6.50	10.0
11,	IV	21.8	2.95	1.00	.29	24.75	1.29	5.21	29.0
12,	I	15.8	2.65	.66	.23	18.45	.89	4.83	34.8
13,	*IV & II	20.2	1.90	.74	.15	22.1	.89	4.03	20.3
14,	III	24.2	4.45	1.02	.34	28.65	1.36	4.75	33.3
15,	*I & II	11.0	1.15	.59	.12	12.15	.71	5.84	20.3
Average yields,		18.4	1.87	.80	.16	20.3	.96	.....	.....
Average per cent. fat,		4.34	8.59	.....	.....	.....	.....	4.73	.....
Gain, per cent.,		.....	**10.2**	.....	**20.1**	.....	.....	.....	.....

Gain in fat: Evening, 20.2 per cent.; morning, 20.0 per cent.
*Evening and morning, respectively.

The total yields for seven of these cows on the first milking were: Milk, 57.8 pounds, and fat, 2.84 pounds; and on the third milking, 48.6 pounds and 2.05 pounds, for milk and fat, respectively, six of the cows giving less milk and less fat on the latter milking than on the former, and one giving more milk and more fat. The average fat content of the mixed milk from these cows came as follows: First milking, 4.91 per cent.; third milking, 4.22 per cent., a diminution of about seven-tenths of 1 per cent.

A RE-TEST OF HERD No. VI.

A twenty-four hour re-test was made on the completion of the preceding test, viz, of cows Nos. 3 and 5, the milkers being now changed and the cows milked by milker No. II. Owing to an accident to milker I, he could not milk a number of the cows milked by the other men on the main test, as had been planned. The results of the re-test are shown below:

	Milk.		Fat.		Per Cent. Increase in Fat.	
	Regular.	Residual.	Regular.	Residual.	On re-test.	On main test.
	Lbs.	Lbs.	Lbs.	Lbs.		
Cow No. 3,	24.2	1.0	.77	.07	9.1	4.4
Cow No. 5,	12.6	1.1	.76	.14	18.4	9.1

Milker No. II left twice as high a percentage of fat in the after-milk as that left by No. I, or on the average, 7 per cent. more. The absolute quantities of fat in the after-milk for the day were: For milker, I, .04 and .07 pound, for cows 3 and 5, respectively; for milker II, .07 and .14 pound, i. e., .10 pound more fat from the two cows. This is equivalent to thirty pounds of fat, worth at least $6.00 for a lactation period of 300 days, which was lost to the owner through the lack of care in milking these two cows alone. We shall later discuss the work of the different milkers in this herd, when the importance of the work of the milker is under consideration.

TEST OF HERD No. VII.

A herd of Red Polled cattle, pure-bred and grade; fifty cows in the herd, mostly grades. Sixteen were milking at the time of the test, of which eight, all grades, were tested. The product from the herd is made into butter, which is sold to commission firms. No records of yield or quality of the milk produced are kept. At the time of the test the cows were kept in the stable at milking time only; the stable is close and low, the cows being fastened in stanchions. Feed, pasture, mostly lowland, no grain or other concentrated feed being given. The milking was done by the foreman and was clean only in exceptional cases. The cows tested were not sucked by calves, but this was the case with all the pure-bred cows in the herd.

Results of Tests of Cows in Herd No. VII.

Number.	Yield Per Day.				Total milk.	Total fat.	Average per cent. fat.	Increase in fat.
	Milk.		Fat.					
	Regular.	Residual.	Regular.	Residual.				
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.		Per ct.
1,	10.8	.70	.48	.06	11.5	.54	5.40	12.5
2,	11.4	1.25	.46	.10	12.65	.56	4.43	21.7
3,	13.7	1.25	.60	.11	14.95	.71	4.75	18.3
4,	10.6	.70	.40	.06	11.3	.46	4.07	15.0
5,	19.2	1.75	.80	.17	20.95	.97	4.63	21.3
6,	14.0	.45	.52	.05	14.45	.57	4.00	9.6
7,	11.8	2.55	.53	.31	14.35	.84	5.85	58.5
8,	16.2	1.35	.90	.19	17.55	1.09	6.21	21.1
Average yields,	13.5	1.25	.59	.13	14.8	.72	.....	.....
Average per cent. fat,	4.36	10.50	.....	.....	4.88	.....	.....	.....
Gain, per cent.,	.....	**9.3**	.....	**22.4**	.....	.....	.....	.....

Gain in fat: Morning, 18.2 per cent.; evening, 29.4 per cent.; second morning, 12.0 per cent.

The cows were after-milked also at the third milking in this and later tests which were conducted, in order that more directly comparable conditions at the first and the third milkings might be obtained. The total yields of milk and of butter-fat in this test was as follows: First milking, 60.4 pounds milk (and 4.05 pounds after-milk), 2.92 pounds fat (.53 pound in the after-milk); third milking, 51.4 pounds milk (and 3.20 pounds after-milk), 2.17 pounds fat (.26 pound in after-milk). Six cows gave less milk and seven less fat on the third milking than on the first milking; the average per cent. of fat in these milkings were 4.22 and 4.84 per cent., respectively.

TEST OF HERD No. VIII.

A herd of pure-bred Holstein-Friesian cattle. About one hundred cows in the herd, fifty of which were milking at the time of the tests, and ten of which were tested. The milk from the herd is separated at the farm, and the cream delivered once a day at a neighboring creamery. A daily milk record is kept, but the quality of the milk from individual cows is not determined. The cows are stabled at milking time in a fine, roomy basement. They are fastened in stanchions, with low partitions between the animals. The cows had run of a good upland pasture and also received light grain rations at the time of the tests. They were milked by four to five milkers. The milking was not, as a rule, thoroughly done, and the time of milking was somewhat irregular.

Results of Tests of Cows in Herd No. VIII.

Number.	Milker number.	Yield Per Day.				Total milk.	Total fat.	Average per cent. fat.	Increase in fat.
		Milk.		Fat.					
		Regular.	Residual.	Regular.	Residual.				
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.		Per ct.
1	III	14.5	1.65	.61	.12	16.15	.73	4.52	19.7
2	III	23.0	1.40	.64	.09	24.4	.73	2.99	14.1
3	IV	28.5	.65	.85	.04	29.15	.89	3.05	4.7
3	III	41.5	.50	1.42	.04	42.0	1.46	3.48	2.8
5	I	36.0	.65	.75	.03	36.65	.78	2.13	4.0
6	III	25.8	.95	.80	.08	26.75	.88	3.29	10.0
7	II	29.0	1.40	.93	.10	30.4	1.03	3.39	10.8
8	I	32.6	.95	1.20	.09	33.55	1.29	3.85	7.5
9	II	23.5	1.50	.78	.11	25.00	.89	3.56	14.1
10	II	13.8	1.10	.50	.08	14.9	.58	3.90	16.0
Average yields,		26.8	1.08	.85	.08	27.9	.93		
Average per cent. fat,		3.12	7.26					3.32	
Gain, per cent.,			**4.0**		**9.2**				

Gain in fat: Morning, 12.7 per cent.; evening, 7.5 per cent.; third milking (6 cows), 8.2 per cent.

Six of the cows tested yielded 72.6 pounds of milk and 4.40 pounds of after-milk on the first milking, and 72.4 pounds of milk with 2.19 pounds of after-milk on the third milking; the total amounts of fat in the regular milkings being 2.68 and 2.19 pounds, for first and third milkings, respectively, and the fat contents of these milkings were 3.70 and 3.02 per cent. Four out of the six cows yielded less milk and five less fat, on the third milking than on the first one.

TEST OF HERD No. IX.

The herd of a general farmer, consisting of seven mature cows, six of which were tested. The milk is delivered to the creamery, where payment is made on basis of its fat content. No milk record is kept, nor tests made of the milk from individual cows in the herd. The cow stable is in the basement of a barn, and is clean and comfortable, the cows being kept in Bidwell stalls. The cows were milked by the owner, except No. 1, which was milked by his wife. The milking was clean, except in case of cow No. 1. All cows were of a quiet temperament; they woud be considered good dairy cows, but had been milking long at the time the tests were made.

Results of Tests of Cows in Herd No. IX.

Number.	Yield Per Day.				Total milk.	Total fat.	Average per cent. fat.	Increase in fat.
	Milk.		Fat.					
	Regular.	Residual.	Regular.	Residual.				
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.		Per ct.
1,	16.1	1.15	.67	.10	17.25	.77	4.46	14.9
2,	6.7	.45	.38	.05	7.15	.43	6.01	13.2
3,	7.0	.75	.37	.09	7.75	.46	5.94	24.3
4,	15.4	.30	.69	.03	15.70	.72	4.59	4.3
5,	14.5	.35	.59	.04	14.85	.63	4.24	6.8
6,	12.2	.55	.51	.06	12.75	.57	4.47	11.8
Average yields,	12.0	.59	.54	.06	12.6	.60	.....	.....
Average per cent. fat,	4.46	10.42	.....	.....	.....	.....	4.74	.....
Gain, per cent.,	.....	**4.9**	.....	**11.5**	.....	.....	.....	.....

Gain in fat: Morning, 10.1 per cent.; evening, 13.1 per cent.; second morning, 13.0 per cent.

The total yield of milk on the first milking was 30.1 pounds, with 1.55 pounds after-milk; on the third milking, 31.7 pounds, with 1.75 pounds of after-milk; the amount of fat in the two regular milkings were 1.68 and 1.62 pounds, and the fat contents 5.58 and 5.11 per cent. for the first and the third milkings, respectively. Four cows yielded more milk and two more fat on the third milking than on the first one.

TEST OF HERD No. X.

The herd of a dairy farmer, consisting of twenty-one cows, of which ten were tested. The milk from the herd is separated at the farm and the cream delivered at the creamery. No record is kept of the milk produced by individual cows or tests made of the same. The cows were kept in Bidwell stalls in a roomy and well-lighted stable. At the time of the test the cows were only kept in the stable at milking time. The cows were fed grain feeds daily in connection with pasture, consisting of equal parts, by weight, of wheat bran and gluten feed. The milking, which was done by one man, was clean but slow, the ten cows being milked in one hour and forty-five minutes ($10\frac{1}{2}$ minutes per cow).

Results of Tests of Cows in Herd No. X.

Number.	Yield Per Day.				Total milk.	Total fat.	Average per cent. fat.	Increase in fat.
	Milk.		Fat.					
	Regular.	Residual.	Regular.	Residual.				
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.		Per ct.
1,	8.0	.35	.45	.04	8.35	.49	5.87	8.9
2,	12.7	.20	.51	.02	12.90	.53	4.10	3.9
3,	17.4	1.05	1.12	.23	18.45	1.35	7.32	20.5
4,	11.7	.70	.59	.08	12.4	.67	5.40	13.6
5,	8.3	.25	.39	.02	8.55	.41	4.80	5.1
6,	8.0	1.10	.42	.16	9.1	.58	6.37	38.1
7,	8.6	.25	.59	.03	8.85	.62	7.01	5.1
8,	12.8	.55	.65	.07	13.35	.72	5.39	10.8
9,	16.7	.40	.72	.05	17.1	.77	4.50	6.9
10,	13.0	3.20	.64	.46	16.2	1.10	6.80	71.9
Average yields,	11.7	.81	.61	.12	12.51	.73	.....	.....
Average per cent. fat,	5.19	14.41	.....	.....	.....	.....	5.78	.....
Gain, per cent.,	.....	**6.9**	.....	**19.1**	.....	.....	.....	.....

Gain in fat: Morning, 19.6 per cent.; evening, 18.4 per cent., and second morning, 14.1 per cent.

The yield from the ten cows on the first milking was 61.0 pounds of milk, and 4.60 pounds of after-milk, and on the third milking, 49.5 pounds of milk, and 2.70 pounds of after-milk. The fat obtained in the regular milkings was 3.52 pounds and 2.20 pounds, and the percentages of fat in the same, 5.77 per cent., and 4.44 per cent. for milkings I and III, respectively. Nine cows produced less milk, and ten less fat on the third milking than on the first one.

TEST OF HERD No. XI.

The herd of a dairy farmer. One hundred and twenty cows in the herd, of which eleven were tested. The milk is separated in a creamery on the farm and made into butter. Milk records are not kept, nor tests of the milk from individual cows made. The cows are stabled in a large, well-lighted and well-ventilated basement stable and are fastened in stanchions. They are fed liberally of a mixture of malt sprouts and brewers' grains fed moistened, also green corn; kept on pasture, except at milking time. The milking was done by four milkers, of which Nos. II and III milked clean; No. III (a woman) milks with the whole hand; the others use the Swiss or Continental method of milking (see p. 22), pressing the teats between the first joint of the bent thumb and the first and second fingers. All milkers wet the teats during milking. The herd consists largely of Holstein and Shorthorn grades, with a few representatives of Brown-Swiss, Jersey and Guernsey grades.

Results of Tests of Cows in Herd No. XI.

Number.	Milker number.	Yield Per Day.				Total milk.	Total fat.	Average per cent. fat.	Increase in fat.
		Milk.		Fat.					
		Regular.	Residual.	Regular.	Residual.				
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.		Per ct.
1	I	6.9	.90	.27	.09	7.8	.36	4.62	33.3
2	I & II	14.5	.85	.65	.09	15.35	.74	4.82	13.8
3	I & IV	12.6	1.25	.54	.13	13.85	.67	4.81	14.1
4	I & IV	10.4	3.80	.43	.31	14.2	.74	5.21	72.1
5	II	26.3	.75	.90	.10	27.05	1.00	3.70	11.1
6	II	16.9	.45	.63	.04	17.35	.67	3.86	6.3
7	II & III	12.0	.25	.45	.02	12.25	.47	3.84	4.4
8	II & III	13.8	.50	.63	.06	14.3	.69	4.83	9.5
9	IV	16.7	.90	.63	.10	17.6	.73	4.15	15.9
10	IV	12.3	.35	.57	.04	12.65	.61	4.82	7.0
11	I & IV	33.5	1.20	1.11	.13	34.7	1.24	3.57	11.7
Average yield,		16.0	1.02	.62	.10	17.0	.72	.....	.....
Average per cent. fat,		3.87	9.91	.....	.....	.....	.....	4.24	.....
Gain, per cent.,		.....	6.4	.....	16.2	.....	.....	.....	.....

Gain in fat: Morning, 18.7 per cent.; evening, 13.5 per cent.; second morning, 14.1 per cent.

Ten cows produced 80.5 pounds of milk and 7.20 pounds of aftermilk on the first milking and 83.1 pounds, with 4.00 pounds aftermilk on the third milking. The regular milkings contained 3.14 pounds and 2.92 pounds of fat, with 3.90 and 3.51 per cent. fat, for milking I and III, respectively. Five cows produced more milk and three more fat on the latter milking than on the former.

TEST OF HERD No. XII.

The herd of a dairy farmer and breeder of Guernsey cattle. Seventeen cows in the herd, of which eight (all pure-bred Guernseys) were tested. The owner conducts a private dairy, separating the cream, and making it into butter, which is sold to private customers. Records are kept of the milk produced by the cows, but no tests made of the milk from single cows. The cows are stabled at milking time in a good barn with cement floor, and are fastened by a loop of rope about the neck, attached to a chain extended between two posts. The first three cows received grain, about three-fourths of the ration being given in the morning immediately after milking. All cows were kept on good pasture. The milking was done by three milkers, of which two milked fairly clean, while No. I left considerable milk in the udder. This milker milks with a jerky, unsteady motion, stopping frequently and changing often from the

front to the rear teats, and vice versa, milking with dry, whole hands and rather slowly. The first three cows tested were entered on tests for the Advanced Registry of the American Guernsey Cattle Club.

Results of Tests of Cows in Herd No. XII.

Number.	Milker number.	Yield Per Day.				Total milk.	Total fat.	Average per cent. fat.	Increase in fat.
		Milk.		Fat.					
		Regular.	Residual.	Regular.	Residual.				
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.		Per ct.
1,.....	I	23.5	1.25	1.36	.16	24.75	1.52	6.13	11.8
2,.....	I	21.8	1.25	.82	.11	23.05	.93	4.05	13.4
3,.....	I	26.8	5.50	1.12	.61	32.3	1.76	5.45	57.2
4,.....	I	16.0	2.80	.71	.23	18.8	.94	5.00	32.4
5,.....	II	22.7	.55	.89	.05	23.25	.94	4.04	5.6
6,.....	II	17.6	.65	.68	.08	18.25	.76	4.16	11.8
7,.....	III	21.7	.50	.91	.05	22.2	.96	4.32	5.5
8,.....	III	16.1	.95	.83	.12	17.05	.95	5.57	14.5
Average yields, ...	.....	20.8	1.68	.92	.18	22.48	1.10	.....	.....
Average per cent. fat, ...	.....	4.40	10.71	.....	.....	.....	.....	4.88	.....
Gain, per cent., ...	.....	.....	**8.1**	.....	**19.7**	.....	.....	.....	.....

Gain in fat: Morning, 22.1 per cent.; evening, 16.7 per cent.; second morning, 10.2 per cent.

The total yields from the eight cows were as follows: 81.3 pounds of milk and 7.95 pounds of after-milk on the first milking, and 69.9 pounds of milk, with 4.45 pounds of after-milk on the third milking, all the cows but one yielding less milk and less fat on the latter than on the former milking, while two yielded the same amount. The yield of fat in the regular milking was 4.08 pounds and 3.52 pounds, with 5.02 per cent. and 5.04 per cent. of fat, for milkings I and III, respectively.

The data for cow No. 3 call for special consideration, owing to the high results obtained. This cow gave 3.80 pounds of milk in the after-milking on August 14, A. M., 1.7 pounds in the evening, and 1.6 pounds in the morning of August 15. The after-milking secured on August 14 contained, as shown in the table, in all .64 pound of butter-fat, equivalent to three-fourths of a pound of butter, a yield considerably above the average total daily production for dairy cows in this or other countries. This cow has a capacious, square, but pendant udder, with rather poorly developed fore quarters. The hind quarters are somewhat bell-shaped and hang slightly lower than the base of the teats. The udder has a rather meaty texture, but a fine skin, with good-sized and even teats. The cow

is considered a very hard milker, so much so, that each one of the attendants is always willing and anxious that somebody else milk her. She was a fresh milker at the time of the test, having been in milk for nineteen days at the beginning of the test.

The first two cows were after-milked during the June tests for the Advanced Registry of the American Guernsey Cattle Club, but through an accident with the testing machine, the separate samples were lost, and their fat contents could not be determined. The yields of regular and of residual milk obtained at that time were as follows:

Yield of Milk for Twenty-four Hours.

	Regular.	Residual.	Total Milk.		Increase in milk.
			Regular.	Residual.	
	Lbs.	Lbs.	Lbs.	Lbs.	Per ct.
Cow No. 1, P. M.,	13.5	1.2	27.5	2.8	**10.2**
Cow No. 1, A. M.,	14.0	1.6			
Cow No. 2, P. M.,	14.7	1.3	27.4	2.2	**8.0**
Cow No. 2, A. M.,	12.7	.9			

The composite sample of the regular and the residual milkings of cow No. 2 for the twenty-four hours contained 5.00 per cent. fat. Assuming that the regular milking contain 4.5 per cent. of fat, and the residual milking about 10 per cent., the amount of fat obtained from the cow was increased by about 18 per cent. by the process of after-milking. The results of the June tests give confirmatory evidence, therefore, that the milking done in this herd, at least by milker I, is in no way such as is apt to produce best results, either as regards the immediate returns secured, or the influence on the development of the milking qualities of the cows or their offspring.

SUMMARY OF RESULTS OF HERD TESTS.

The main results of the tests of cows in the twelve herds reported in the preceding pages have been summarized in a single table below, which will show at a glance the average production of the cows tested in the different herds, the amounts of milk and butter-fat obtained by the manipulation method of milking, the percentage gain in fat, with range in gain, etc.

Summary of Results of Tests of Cows in Herds Nos. I—XII.

Herd No.	Number of cows tested.	Av. Yield Per Day.		After-Milking.		Av. Gain.		Range in gain of fat for individual cows.	Residual fat over 10 per cent.	Residual Milk per Day Less Than	
		Milk.	Fat.	Milk.	Fat.	Milk.	Fat.			5 pounds.	1 pound.
		Lbs.	Lbs.	Lbs.	Lbs.	Per ct.	Per ct.	Per ct.	No. of cows.	No. of cows.	No. of cows.
1, ...	11	23.1	1.09	.75	.09	3.2	8.1	2.2-22.3	3	3	8
2, ...	10	49.0	1.66	1.79	.14	3.7	8.3	2.7-23.6	3	0	4
3, ...	12	31.2	1.58	.55	.07	1.8	4.4	1.5-11.3	2	5	11
4, ...	8	25.5	1.10	.76	.08	3.0	7.5	2.2-15.9	3	2	5
5, ...	8	18.6	.83	.61	.07	3.2	7.9	3.8-12.5	4	2	8
6, ...	15	28.4	.80	1.87	.16	10.2	20.1	4.4-37.5	12	2	5
7, ...	8	13.5	.59	1.25	.13	9.3	22.4	9.6-58.5	7	1	3
8, ...	10	26.8	.85	1.08	.08	4.0	9.2	2.8-19.7	6	0	5
9, ...	6	12.0	.54	.59	.06	4.9	11.5	4.3-21.3	4	3	5
10, ...	10	11.7	.61	.81	.12	6.9	19.1	3.9-71.9	5	4	7
11, ...	11	16.0	.62	1.02	.10	6.4	16.2	4.4-72.1	7	3	8
12, ...	8	20.8	.92	1.68	.18	8.1	19.7	5.5-57.2	6	0	4
Univ. herd, ..	25	22.3	.93	1.01	.09	4.5	9.2	3.0-30.2	11	2	12
Total & av.	142	.....	.....	**1.08**	**.10**	**5.3**	**12.6**	1.5-72.1	77	27	85

We shall not discuss these results in detail at the present, but only call attention in this place to the fact that the total number of cows tested by the writer in his investigation was 142; the average gains obtained by the process of after-milking, over and above the production of the cows secured by the ordinary method of milking, were 1.08 pounds of milk and one-tenth of a pound of fat per day per head, the range in the former figure for the different herds examined being .55 and 1.87 pounds, and in the latter .06 to .18 pound. In per cent. of the regular production these figures amount to 5.3 per cent. on the average, for the increase in milk (minimum 3.0 per cent., maximum 10.2 per cent.), and 12.6 per cent. of fat (minimum 4.4 per cent., maximum 22.4 per cent.). The individual cows tested showed gains in the production of fat ranging from 1.5 per cent. to 72.1 per cent., 77 cows (out of a total number of 142) giving a percentage gain in fat of .1 pound or more; 115 cows gave down more than a pound of milk by the manipulation of the udder, and 57 cows gave down more than one pound of extra milk per day per head. Since the strippings obtained by the manipulation test over 10 per cent., one pound of milk of this kind contains at least one-tenth of a pound of fat, and is equivalent to about two and a half pounds of ordinary milk.

ON THE PERSISTENCY IN THE GAIN IN PRODUCTION.

The results of the examinations of cows in the different herds given in the preceding pages have been arranged so that comparisons may be made between the yields of milk and fat from indi-

vidual cows on the first and the third milkings of the tests, and between the average per cent. of fat for these two milkings in the milk from all cows tested. Summarizing these data, we find that in twenty-two cases there was a higher yield of milk, and in ten cases a higher yield of fat on milking I than on milking III; in fifty-nine cases a lower yield of milk and in fifty-six cases a lower yield of fat, while in two and five cases, the same yields of milk and fat, respectively, was obtained on both milkings. These results show, with considerable certainty, that a milking immediately succeeding one where the manipulation method has been practiced, is apt to be lower in milk, and especially lower in fat, than the corresponding milking following an ordinary milking, and in the case of eight out of nine herds the average fat content of the milk was lower at the former milking than at the latter.

It might, perhaps, be expected when the udder of a cow is so completely emptied of milk as occurs by practicing the manipulation method, that less than normal amounts will be obtained at the next milking. When a longer period is considered, however, no such depressing influence is apparent; on the contrary, we found, on the main experiment with cows in our University herd, previously reported, a somewhat increased yield on regular-milking days, compared with that of regular milkings alone on days when after-milking was practiced. If we are justified in accepting this evidence as conclusive, as it would appear that we are, it follows that the milk glands of the cow, after a short time, are able to adjust themselves to the thorough emptying of the udder and are stimulated thereby to an increased production. As a matter of fact, this was also found to be the case with the cows on the experiment referred to, which showed a decrease in production on the third milking over the first one, but an increase on later corresponding milkings.

A MILKING EXPERIMENT.

In order to secure some further direct evidence on this point, an experiment with two cows in our University herd was conducted during the past fall and winter. The cows were after-milked regularly every milking by our milker No. IV during the latter halves of their lactation periods after having first been milked clean by him by the ordinary method of milking; the two lots of milk were kept separately, weighed and sampled, and composite samples for a week at a time tested by the Babcock test. The data presented in the following table show the weekly yields per cow of both regular and residual milk and butter-fat up to the time the cows were dried off, as well as the percentage increase in the production of fat ob-

tained for every week through the process of after-milking. These two cows were selected for the experiment, as their production did not come up to expectations, and it was thought possible that by a careful system of after-milking during the remaining portions of their lactation periods, they might maintain a good flow of milk longer and would not go dry as early as they were apt to do otherwise.*

Reba dropped her last calf prior to the experiment on February 25, 1902; she had, therefore, been in milk for 141 days at the beginning of this experiment, and was due to calve in seven months, while Mary had given milk 173 days and was about eight months from calving at this time. Reba was milked by milker III and Mary by milker I during the main experiment, June 10-July 16. The cows were treated as nearly alike as possible during this new experiment; they were milked every time by the same man, at the same hours, and in the same order, with only absolutely necessary changes in their food rations. The following table of weekly summaries shows the yields of milk and butter-fat in the regular and residual milk which were secured during the last six months of the lactation periods of the cows.

Results of After-Milking Tests with Reba and Mary; Weekly Yields.

	Reba.					Mary.				
	Milk.		Fat.			Milk.		Fat.		
	Regular.	Residual.	Regular.	Residual.	Gain in fat.	Regular.	Residual.	Regular.	Residual.	Gain in fat.
First week on milking experiment:	Lbs.	Lbs.	Lbs.	Lbs.	Per ct.	Lbs.	Lbs.	Lbs.	Lbs.	Per ct.
June 10-18,	.....	.....	.....	.....	.....	76.3	13.05	3.24	1.12	34.6
June 18-25,	198.2	6.30	9.36	.80	8.5	.....	.....	.....	.....	.....
July 16-23,	129.5	14.75	5.83	1.47	25.2	80.8	5.55	3.72	.51	13.7
July 23-30,	121.2	18.35	5.09	1.74	34.2	77.5	5.65	3.57	.55	15.4
July 30-Aug. 6,	106.6	22.85	4.16	2.29	55.0	72.6	5.85	3.30	.61	18.5
Aug. 6-13,	128.2	12.60	6.41	1.56	24.3	68.4	5.90	2.91	.58	19.9
Aug. 13-19,	145.5	15.80	6.98	1.93	27.7	67.6	5.75	3.11	.60	19.3
Aug. 19-26,	137.8	11.35	6.89	1.33	19.3	69.2	5.35	3.25	.54	16.6
Aug. 26-Sept. 3,	130.9	6.70	6.28	.67	10.7	68.0	4.00	2.99	.38	12.7
Sept. 3-10,	117.1	8.60	5.74	.80	13.9	66.0	4.80	2.97	.46	15.5
Sept. 10-17,	108.9	9.20	5.39	.85	15.8	68.2	4.55	3.00	.34	11.3
Sept. 17-24,	100.4	7.25	4.97	.80	16.1	59.1	3.15	2.84	.30	7.0
Sept. 24-30,	82.9	8.80	4.23	.79	18.7	57.2	3.45	2.77	.36	13.0
Oct. 1-7,	71.1	10.55	3.89	1.00	26.3	51.1	3.40	2.43	.35	14.4
Oct. 8-15,	74.8	10.25	3.74	.95	25.4	54.3	3.85	2.72	.47	17.3
Oct. 15-22,	69.5	7.70	3.27	.62	19.0	57.4	3.45	2.76	.31	11.2
Oct. 22-29,	45.5	8.90	2.35	.77	32.8	45.9	4.35	2.30	.43	18.7
Oct. 29-Nov. 5,	47.3	6.85	2.51	.59	23.5	42.3	4.52	2.08	.48	23.1
Nov. 5-12,	59.0	7.40	3.10	.68	22.0	41.0	3.90	2.38	.41	17.2
Nov. 12-19,	42.0	6.85	2.48	.65	26.2	36.8	2.80	2.17	.31	14.3
Nov. 19-26,	37.3	3.75	2.09	.32	15.3	35.1	3.60	2.00	.37	18.5
Nov. 26-Dec. 3,	35.4	3.60	2.09	.32	15.3	41.0	2.65	2.21	.27	12.2
Dec. 3-10,	20.8	4.45	1.79	.38	21.2	34.8	3.25	1.88	.33	17.6
Dec. 10-17,	27.1	4.45	1.46	.38	26.0	30.3	3.15	1.61	.30	18.3
Dec. 17-24,	21.5	6.00	1.18	.55	46.6	28.8	2.80	1.70	.29	17.1

*See Wis. Experiment Station Bull. N. 102, pp. 24-25.

We note that Mary was fairly regular throughout the experiment as regards the amounts given down by the manipulations, while the results obtained with Reba varied greatly, especially during the months of July and August, when she often held up a couple of pounds of milk at a milking, which could only be obtained by means of the manipulation method. There does not appear to be any diminution in the percentage increase of fat or milk secured during the progress of the lactation period. On the contrary, the gain remains fairly uniform, increasing somewhat toward the end of the milking period. The absolute quantities of residual milk and fat, on the other hand, decreased with the natural diminution in production due to the advance of the lactation period. There is no evidence that the regular production of the cows (i. e., that obtained by the ordinary method of milking) was at all reduced by the drawing of the extra amounts of milk by the manipulation process.

Reba gave down 2,067.5 pounds of milk by the ordinary method of milking during the weeks when she was after-milked, and this yield was increased by 223.3 pounds by the process of after-milking, or 10.8 per cent. The amount of fat in the milk obtained by the ordinary method of milking during this period was 101.19 pounds, and that in the after-milk 22.24 pounds, i. e., the butter-fat production of the cow was increased by 22.0 per cent. In the same way we have, for the other cow: Regular milking, 1,329.7 pounds milk and 63.91 pounds of fat; after-milking, 108.77 pounds milk, 10.67 pounds fat,—an increase of 8.2 per cent. in the production of milk and of 16.7 per cent. in the production of fat.

The average fat contents of the milk from the two cows for the time they were on the experiment just described were as follows: Reba, 4.89 per cent.; Mary, 4.81 per cent. If the after-milking be added to the mess of milk, the fat content of the entire production would be: for Reba, 5.39 per cent., and for Mary, 5.18 per cent., an improvement in quality amounting to .50 and .38 of one per cent., for Reba and Mary, respectively.

DISCUSSION OF RESULTS OF MILKING EXPERIMENTS.

The manipulation method has been investigated by the author in three different experiments up to the present time, which have furnished data for 142 different cows as to the amounts of milk and butter fat obtained by a system of clean milking, combined with manipulation of the udders of the cows. The majority of the tests made with these cows were for the brief period of three milkings, only twenty-four cows in our University herd having been kept on the test for a longer time, viz: for five weeks, and two cows among these for over six months. Judging from the results

obtained during these longer experimental periods, we feel safe in concluding, however, that the results of tests conducted for two or three successive milkings give a fair indication of the direct, every-day losses in dairy herds due to careless, or not sufficiently careful, milking, and that the results of the brief tests are at all events not appreciably too high, owing to the conditions under which the tests were conducted. (See p. 33.)

The average results of the determinations of the amount of milk and butter-fat obtained in the after-milk in case of the 142 cows have been compiled and a summary of the compilation is presented below:

Amounts of Milk and Butter-Fat in Residual Milk, Per Day. Summary for 142 Cows.

Residual Milk.	Number of cases.	Per cent. of total No.	Residual Fat.	Number of cases.	Per cent. of total No.
Lbs.			Lb.		
.20— .25	9	6.3	.02— .05	44	31.0
.26— .50	28	19.8	.06— .10	55	38.8
.51— .75	30	21.1	.11— .15	21	14.8
.76—1.00	19	13.4	.16— .20	6	4.2
1.01—1.25	21	14.8	.21— .25	8	5.6
1.26—1.50	12	8.5	.26— .30	2	1.4
1.51—1.75	7	4.7	.31— .35	3	2.1
1.76—2.00	2	1.4	.36— .40	1	.7
2.01—2.50	1	.7	.41— .50	1	.7
2.51—3.00	5	3.5	.51— .64	1	.7
3.01—3.50	3	2.1			
3.51—4.00	2	1.4			
4.01—4.50	2	1.4			
4.51—5.50	1	.7			
Total, ...	142	100.0	.....	142	100.0

The largest amount of milk per day in the after-milk from any one cow was 5.5 pounds and of fat, 0.64 pounds, the smallest amount being 0.20 and 0.02 pound of milk and fat, respectively. The figures in the table show that about one-fourth of the number of cows gave down less than one-half of a pound of residual milk, about one-third gave between one-half and one pound, and nearly another third gave between one and two pounds. Ten per cent. of the cows gave more than two pounds of milk per day in the after-milking. The average amount of residual milk for the 142 cows was, as we have already seen, 1.08 pound per head per day.

Considering the amounts of residual fat per day obtained, we find that a little over two-thirds of the cows gave less than one-tenth of a pound of butter-fat in the after-milking, 30 per cent.

giving more than this amount. The extremes found were 0.02 and 0.64 pound, and the average for all the cows one-tenth of a pound per day per head.

CLEAN MILKING vs. MANIPULATION.

From the results of the investigations so far made, we feel warranted in stating that when due care is taken in milking the cows, less than half a pound of milk per day extra will, as a rule, be obtained by the use of the manipulation method with good dairy cows that are in full flow of milk, and with perhaps a majority of such cows this amount will come nearer a quarter of a pound, than half a pound; but in every herd so far examined we have found some cows that would be considered excellent dairy animals, which have given down toward one pound of milk per day extra, or more, representing at least one-tenth of a pound of butter-fat. The lowest maximum amounts of milk and butter-fat found in the after-milking in any of the herds tested by the writer up to the present time, were 0.8 pound of milk and 0.09 pound of fat, and, judging from the results obtained with the herds tested, it seems evident that it is only under exceptional conditions and with very careful milking that some cows in a herd will give as small quantities of milk and butter-fat in the after-milking as this.

The preceding figures naturally presupposes clean milking. Where the cows are not milked clean, the figures are higher and will come as shown in the data for the various herds examined. The average quantities of milk and fat obtained in the after-milking in case of these herds were about one pound of milk and one-tenth of a pound of fat per cow and per day; it follows from what has just been said that perhaps the greater portion of these amounts would have gone into the milk drawn by the ordinary method of milking, had this been thoroughly done in all cases.

OTHER AMERICAN TESTIMONY CONCERNING THE MANIPULATION METHOD.

There has not been published any reports of other investigations of the manipulation method of milking in this country at the present writing, but some limited practical experience has been gained and the opinions of some dairymen and others as to the value of the method are on record.

The testimony of a Maine farmer is as follows:* "We have been practicing manipulation after milking perfectly dry, and get from one-half to one pint from cows in full flow, and have increased the

*New York Produce Review, Jan. 21, 1903.

amount of cream from one-half to three-fourths of an inch on a common Cooley can, and I believe the dairymen of Maine should take every advantage possible to increase the products of their herds and not condemn new ideas until after having given them a thorough trial they find them of no value."

A correspondent of the Rural New Yorker* says, regarding the method: "My experience of the past six weeks leads me to believe that it would be quite useful. Being short of cream, I tried to get just all of the milk possible from my cows, and in so doing I did more stripping than usual; in consequence, some of my milk, though not very much, was exceedingly rich in butter-fat. I have not had it tested, but should think it would test as much as eight per cent., if not more. I think it pays from the extra milk and cream we get, but I think that with heifers it would naturally induce them to give more milk and for a longer length of time."

A good many of the criticisms of the manipulation method have come from farmers whose only knowledge of the method is derived from published descriptions of the same in the dairy press or Bulletin No. 96 of the Wisconsin Experiment Station. It is readily granted that the method may seem laborious, and perhaps even impractical, on paper, but its practicability will be decided by actual trials in the dairy and not by "don't thinks" or mere assumptions. We shall, later, consider the practical aspects of the method and shall then have occasion to discuss objections that have been raised to it and give reasons for our belief that the method is both of great practical value and of vital importance to the dairy industry of this and other countries. For the present, the evidence as to the gains obtained by the manipulation method will be further considered.

TESTIMONY FROM ABROAD.

The first testimony on record as to the value of the manipulation method naturally came from Denmark. As the method became known and adopted in other countries, like Norway, Sweden, Finland, Germany, Austria, etc., evidence was recorded in the agricultural and dairy press of these countries, until quite an array of practical experience is now available. We shall briefly give a resume of accounts of these experiences published up to the present time. Dr. Hegelund's investigations led him to believe that the yields of milk would be increased by one to two pounds per head per day† through the adoption of the method of milking that bears his name; this is equivalent to two and a half to five pounds of milk of ordinary quality.

*1902, pp. 815, 830.
†Landtmannen, 1902, No. 42, p. 673.

Chr. Worm, in his description of the Hegelund method,* gives examples of the improvement in the milk yields of cows in Danish herds brought about by the adoption of the Hegelund method. In one case the cows gained one to one and a half pounds of after-milk per day, on the average; in another case the milk yield from eight cows was increased from 165.2 pounds a day to 175.9 pounds a day during the following week, an absolute gain of over ten pounds of milk per day from the group, not considering the natural decrease in milk flow due to the advance of the period of lactation.

In a trial reported from Norway,† two groups of cows of five each were milked according to the Hegelund method for fourteen days, group I being after-milked during the first week, and group II during the second week; the feed and other conditions remained similar throughout the experiment. Group I gave 94.6 pounds more milk during the first week than during the second one, and group II gave 90.2 pounds more during the second week than during the first one; the average daily increase in the yield of milk, therefore, amounted to 2.64 pounds per head.

A trial with seventeen cows in another dairy showed an increase in the average production of butter-fat amounting to 17 per cent., when the milkers did not know that their cows were going to be after-milked, and to 14 per cent. when they did know what was to come, i. e., an extra pound was secured for each seven pounds of butter-fat produced.‡

In another series of trials, cows gave 0.7 to 1.5 pounds more milk per head daily when the manipulation method was practiced, although the cows were milked by good and careful milkers, and the milkers knew that their work would be followed up by manipulations of the udders.§

A brief trial with four cows is reported from Finland.|| The cows had been going down normally in milk, but increased nearly seven pounds during three days on the manipulation method, viz, 1.1, 0.4, 1.7 and 4.0 pounds. From the account given of the trial no other explanation is feasible than the influence of the manipulations on the secretion of milk.

An increase of one to two pounds of milk per head daily, as the result of introducing the manipulation method,** is reported from Oldenburg, Germany, in an experiment with five cows; on the average for all trials, an increase of 1.8 pounds of milk and 0.08 pound of fat per head per day was obtained.

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*Loc. cit., pp. 36-39.
†Norsk Landmandsbl., 1901, p. 366.
‡Norsk Landmandsbl., 1901, pp. 529-531.
§Ibid, 1901, p. 563.
||Tidn. f. Mjölkhush., 11, p. 191.
**Biedermann's Centralblatt, 1903, p. 200; Oesterr. Molkerei-Ztg., 1902, p. 256.

Another experiment in a German dairy gave the following results: Ten cows were after-milked for fourteen milkings; the average yields per milking were 130 pounds of milk by the ordinary method of milking, and 4 pounds of after-milk; the average production of fat was 4.5 pounds in the regular milkings and 0.66 pound in the after-milk, i. e., an increase in production of 14.5 per cent.*

According to Mr. A. Alfonsus, an Austrian instructor in dairying, cows in his dairy herd which were milked clean by careful milkers, often gave half a pint more milk by the Hegelund method than when milked in the ordinary way; the extra milk thus obtained contained mostly 8 to 12 per cent. of fat, and was, therefore, two and a half to three times richer than the normal milk of the herd.† At a large Austrian dairy farm, where the new method of milking was introduced, single cows gave one and a half to two liters (three and a half to four pounds) of milk extra per head with this method, and the quality of the milk from the herd was improved by an increase of 0.3 of one per cent. in its fat content.

The following bit of testimony comes from the opposite side of the world, from New Zealand, where the manipulation method was introduced through the publication of Bulletin No. 96, of the Wisconsin Experiment Station, in the New Zealand Dairyman:‡ "We duly received our copy of December Dairyman, and were at once struck with the pictures illustrating the manipulating of the cow's udder and determined to try for ourselves, and now I give you the most gratifying results. Our test was standing at 3.5, and the last seven days of December we tried your manipulating scheme and it jumped to 3.8, just making a difference of 2 s. (48.6 cents) per day extra to us. My neighbor also tried it, and his test rose from 3.6 to 3.9. There is no need to tell you we intend to continue with it."

A later letter from the same correspondent states that the method has made an increase of about 12 per cent. in the production of his herd of twenty cows, and that his test rose an additional tenth of a per cent. the second week, making the total increase four-tenths of one per cent.

None of the results quoted in the preceding are offered as conclusive proof of the superior value of the manipulation method of milking over ordinary methods, but rather as corroborative evidence in this line. The results will hardly bear close scrutiny in several cases, as we have no assurance that accidental conditions may not have had an influence in determining the result which is now explained as the sole effect of the change in the method of milking; but, coming from prominent and progressive dairymen and dairy instructors in widely scattered countries and

*Deutsche Landw. Presse, 1902, p. 51.
†Die zweckmäss. Ausführ. d. Melkarb., pp. 24-25.
‡Jan. 20, 1903 (Communication to the Editor of the N. Z. Dairyman).

all telling practically the same story, we may safely accept the conclusions which the results lead to, as confirmatory evidence, and may consider the deductions drawn from the results of the author's experiments regarding the value of the manipulation method of milking fully warranted by facts.

The average gain in the production of butter-fat obtained by the manipulation method of milking calculated on basis of the yield secured by the ordinary method of milking, was 12.6 per cent., as shown in the summary table on p. 50; the results ranged from 4.4 to 22.4 per cent., and in six out of the thirteen herds examined the percentage gain exceeded 10 per cent. Since a number of the herds examined belong to the best managed dairy herds in the State, the conclusion seems amply warranted that the average gain obtained is well within the limits of the increase that may be expected if the manipulation method is generally introduced on the dairy farms of our country. The gain of ten per cent. in the production of butter-fat assumed in the Introduction which would result if this method was generally adopted may, therefore, be safely considered a low estimate; hence, the economic value of the method to our dairy industry and the need of greater attention being given to this subject of milking than has heretofore so often been the case.

DISCUSSION OF THE MANIPULATION METHOD OF MILKING.

We have presented evidence furnished by carefully-planned and somewhat lengthy experiments in the preceding, which shows that an appreciable increase in the immediate production of butter-fat and milk from dairy cows can ordinarily be obtained by manipulations of the udder. It will now be in order to examine into other points in connection with the method bearing on its practicability and economy, viz: First of all, the effect of the manipulations on the cows themselves, the cost of this method of milking, the effect on the quality of the products obtained, and similar questions that present themselves for consideration and must be decided before the merits of this system of milking can be deemed established and its adoption safely advocated.

We shall briefly consider these questions in their order. It must be borne in mind, however, that our present knowledge in regard to some of the points raised is limited; only a few extended critical investigations of the manipulations have been conducted, or at any rate published up to the present time, in this or in foreign countries, and but little accurate practical testimony is available from this country or from abroad. Hence, it is not to be expected that entirely satisfactory and decisive answers to the above questions can be made in all cases. It will require years of careful study and close observation to settle some points bearing on the merits

of the method that present themselves, especially as to the cumulative effect of the exhaustive milking on the development of the milk glands of the cows and of their dairy qualities. It is believed, however, that the results presented in the preceding and the practical experience and testimony now at hand will warrant the statements made in the following pages.

THE EFFECT ON THE COWS.

Of the cows on which the manipulation method has been tested so far, numbering over 150 in all and belonging to all the different dairy and dual-purpose breeds, with only one or two exceptions, less than a dozen have in any way objected to the manipulations. The part of the method which these few cows did not like was generally the third manipulation. These cows or heifers were, as a rule, of a very nervous temperament, and more or less inclined to give trouble also by the ordinary method of milking. The large majority of cows, on the other hand, seem to like the method; they stand chewing their cud when after-milked, and are apparently at as perfect peace with the world and their immediate surroundings while the process of after-milking is going on, as when milked in the ordinary way. The effect of the manipulation on the development of the dairy qualities of the cows and their offspring will be considered presently.

THE COST OF THE MANIPULATION METHOD.

The question of the cost of the method is one of vital importance, for no matter how many advantages the method has in other respects, it will have no practical value if the expense of it is apt to come higher, or not appreciably lower, than the value of the increased production or of other points that the method may have in its favor. The cost of the method is mainly dependent upon the length of time required to do the milking by this method, since the food question, if at all affected by the increase in production, is of minor importance on account of the high value of the manufactured products. The time required to go through the various manipulations by the Hegelund method will, of course, depend on the practice that the milker has obtained and whether he is a rapid milker or not; at first, the manipulations may take four or five minutes, but when the milker has become more familiar with them, they will not require more than a couple of minutes, and as we shall see presently, the work may be so arranged that the total time spent in milking will not be longer with the manipulation method included than is now the case without the same. There is a considerable difference in case of different cows as to the efficiency of the manipulations to bring down the last portions of the

milk in the udder of the cow at the time of milking. Some cows give down nearly all the milk remaining in the udder on the first manipulation and only a little on the other two manipulations, while others continue to give down a little milk throughout the process of after-milking. With cows of the former kind, it is not necessary to go through all three parts of manipulations II and III, and the time of after-milking such cows may, therefore, be somewhat shortened.

We found, in our experiments, that one man can readily after-milk twenty cows an hour, if there are no extra weighings, sampling, or recording of weights to be done. We pay hired help fifteen cents an hour for milking at this Station. This may be considered a rather high price under present conditions in Eastern and Northwestern States. The after-milking of twenty cows would take a man two hours a day, and would, therefore, cost thirty cents at the rate given. We have seen that we obtain, on the average, an immediate increase of about a tenth of a pound of butter-fat per cow by the process of after-milking, or from twenty cows, two pounds of butter-fat. If butter-fat is worth twenty-five cents a pound (an average figure), the value of the increased yield would be fifty cents; that is, there would be a net gain of twenty cents a day per twenty cows, or about $60.00 a year, calculated on an average lactation period of 300 days, as the direct and immediate gain from practicing the manipulation method. If the value of the fat be less than twenty-five cents a pound the gain would be correspondingly reduced, but the account would at all events be likely to come out on the credit side, even if only immediate results are considered.

The preceding calculation is based on the supposition that the manipulations will take two minutes of extra time. But, as before suggested, it will not be necessary to spend this much additional time unless the work of milking is done as in the experiments conducted so far at our Experiment Station, where the work of milking has been separated into two parts, the ordinary milking and the after-milking, these being done either by different or by the same milkers. It is not necessary to adopt this plan in order to secure a maximum yield of milk from the cows. The method that, for several reasons, seems preferable in the practical work on dairy farms, is for all milkers to learn the manipulations and to use them as soon as a full flow of milk is no longer obtained by the ordinary method of milking. There is no need of stripping the cows at all when the after-milking thus follows directly after the ordinary milking, for the milk left in the udder by this method of milking will be readily brought down by the manipulations; since the time it takes to strip the cows would ordinarily suffice for the

manipulations, it is safe to say that the process of after-milking conducted in this way will not take a minute longer than ordinary clean milking. One of the essential points in the new method of milking is, furthermore, that the udder is emptied in full streams, which come as fast as the milker can do the work and without any interruption from beginning to finish (see p. 18); the total time spent in milking, therefore, is reduced to a minimum by this method, and with the manipulations following without delay when the milk does not come in full streams any longer, there will be no extra expense connected with the manipulation method, or this will, at any rate, be too small to be worth considering.

THE MANIPULATION METHOD FOR COWS ON OFFICIAL TESTS.

There are certain cases where the cost of milking does not enter into consideration, as e. g., in competitive tests where a maximum production of milk and butter-fat is aimed at, or where the production of an animal has to reach a certain standard in order to be admitted to the Advanced Registry of one of the various breed associations. In such cases the value of the offspring is increased in proportion to the record made by the dam, and a slightly increased expense of milking for a limited period is of no consequence. Many of the tests with the manipulation method which have been reported in the preceding were made with pure-bred cows, and in a number of cases the production of the cows was increased much beyond the gains ordinarily obtained, by taking the after-milking into consideration. Some instances may be cited: The daily production of fat was increased in case of two pure-bred Guernsey cows by 57.2 and 22.3 per cent. (herds No. 12, cow 3 and No. 1, cow 6); two Holstein-Friesian cows gave an increase of 23.6 per cent. and 19.7 per cent. (herds No. 2 and 8, cows 10 and 1, respectively); a Jersey cow, 22.3 per cent (third experiment, University herd, Reba); a grade Shorthorn cow, 32.5 per cent. (first experiment, University herd, cow 2); a grade Red Polled cow, 58.5 per cent. (herd No. 7, cow 7), and so forth.

Cows on "Official Tests," or entered in other competitive contests, are, as a rule, milked by the owners themselves, where these take part in the milking, or by some milkers that have the full confidence of the owners. The preceding results were obtained by one or the other of these classes of milkers, or by milkers who were supposed to do their work well. The cows entered on these tests are, in general, in full flow of milk at the time of testing and give down their milk readily, so that the after-milking does not often give as high results as those shown above, but even if the increase in the production of fat in the manipulation method is assumed to be

10 per cent., or below the average of all results obtained by the writer up to the present time, we still have a figure that is sufficiently large to entitle the new method of milking to serious consideration by breeders and dairymen who are desirous of getting maximum results from their cows.

STRIPPING COWS AFTER THE MILKING IS DONE.

The question is sometimes asked whether it is a good plan to have a man go over all the cows in a herd as the regular milkers are through and carefully strip the cows, or whether it is not better to milk the cows just fairly dry and then leave them. As already stated, the better way is to finish the milking at once without interruption, and it is not believed that the plan of keeping one man to strip all the cows, or as many as he can go over, after the regular milkers are done, is to be commended. A cow will do her best with the milker she is accustomed to; when she has started to give down her milk freely, its removal from the udder through the act of milking creates somewhat of a suction in the udder, of which advantage should be taken by milking in full, rapid streams, continuing until the milk does not come down this way any more, when manipulations are resorted to. Clean milking is absolutely necessary if the cow is to keep up a good flow of milk through the lactation period; by following up the regular milking at once with the manipulations, advantage is taken of the disposition of the cow to give down all the milk there is in her udder at the time of the milking, and maximum results thus obtained. The writer is, therefore, of the opinion that it will pay a farmer owning a large dairy herd to have his several milkers learn and practice the manipulation method in the way suggested rather than have one man strip all the cows after the cows are milked fairly dry by the regular milkers.

LEARNING THE MANIPULATION METHOD.

The method is easily learned by any person who knows how to milk. It takes a little time before one can become thoroughly familiar with the various steps in the manipulations and before some degree of expertness can be reached, but an intelligent and observing milker will not be apt to begrudge the time spent in becoming familiar with the different manipulations, since the results obtained will prove stimulating and will furnish an incentive to good work.

Persons learning the manipulations are, as a rule, apt to make too hard work of it. According to the experience of the writer, the manipulations should be done rather lightly, so as to cause no

irritation to the cow or waste of energy on part of the milker. It requires but very light manipulations to bring down the residual milk in the udder nearly as completely as is possible by doing a hard task of the manipulations.

While it is true that anyone who already knows how to milk may learn the manipulation method without too much trouble, it is also true that many milkers will have to unlearn peculiarities in their way of milking; for this reason, and on account of the small effort learning new ways costs the young, the best time to learn the new method of milking is when the boy or girl starts in to milk. This view of the matter is taken by those who have given this subject much thought, and we consequently find schools for the instruction of young milkers in the manipulation method in countries where the subject of milking has received most attention. Here is a work for elementary agricultural and dairy schools and short courses in agriculture which bids fair to bear fruit in an improvement in methods of milking and in creating an active interest in one of the fundamentals of successful dairying.

PRACTICAL COURSES FOR MILKERS.

The importance of the subject of thorough methods of milking has been recognized by the governments of several European countries where dairying is an important industry, through the appointment of special dairy instructors in milking and by providing for brief practical courses for milkers where the manipulation method of milking is taught and popular lectures on the main principles underlying dairy husbandry are given. Such courses have at this time been established in all the Scandinavian countries and in Austria. Denmark took the lead, as has been usual in dairy matters during the last twenty years or more, and made an annual appropriation for the promotion of this work through the establishment of schools for milkers. The first course of this kind, held at Tune Agricultural School, in July, 1900, was not largely attended, but for the second course, held September, 1900, fifty-seven applications were received, of which nearly twenty had to be turned away on account of lack of accommodations. Among those that were accepted were twenty-one farmers' wives (milking is done mostly by women in Denmark, as in European countries generally), one was an instructor in agriculture, three assistants of so-called Control-Associations, and five herdsmen, of whom three were married men.*

Since that time these courses have been held regularly with short intervals. During the first year 472 students attended the course, and during the second year 696. Up to November, last year, about 3,000 young men and women had attended these Dan-

*Ugeskr. f. Landm., 1900, p. 465.

ish milking courses, and have been drilled in the use of the manipulation method. The time is, therefore, apt to come, as has been predicted, when all in that little country who are in any way ambitious to make their dairy pay, will either have attended one of these courses themselves, or have sent their sons and daughters or their milkers to attend them. The courses last only six days, from Monday noon to Saturday noon, and are limited to thirty students. Experience has shown that this time is sufficient to give the students practical knowledge of the manipulation method of milking so that they can use the method at home, and at the same time they receive instruction in the proper care and handling of dairy stock through plain talks and demonstrations.

The effect of the general increase in knowledge concerning the cow herself and the importance of the work of milking brought about by these brief and inexpensive courses can hardly be overestimated. Evidence has been presented from many quarters showing how the interest awakened in the work of the dairy through attendance at one of the milking courses has been of the highest direct value to the farmer in the conduct of the dairy, as well as of indirect value through the better understanding of the principles of modern dairy methods which the instruction at the milking course left with the students.

Similar courses have been established in the other European countries mentioned, through private enterprise or through the efforts of county or State agricultural societies, and special teachers have been appointed to give instruction and assistance in questions pertaining particularly to methods of milking and management of dairy herds.

INFLUENCE OF THE MANIPULATION METHOD ON THE QUALITY OF THE MILK PRODUCED.

We have seen that the last portion of a milking is considerably richer than the average normal secretion of a cow, and that this is an argument in favor of securing the strippings, especially when this can be done without injury to the cow and without rendering the work of milking more difficult or appreciably slower, as is the case by the manipulation method of milking. In order to show by actual figures, how the composition of the residual milk obtained by this method differs from that of normal milk, the main average results for the different herds, including the University herd, secured by the writer in the previously described milking experiments, have accordingly been brought together, and are given in the following table:

Average Fat Contents in Regular and Residual Milkings.

	Average for number of cows.	Regular milking.	Residual milking.	Ratio.
		Per cent.	Per cent.	1:
University herd,	25	4.12	8.42	2.0
Herd No. 1,	11	4.71	11.83	2.5
Herd No. 2,	10	3.38	7.71	2.3
Herd No. 3,	12	5.08	12.68	2.5
Herd No. 4,	8	4.31	10.81	2.5
Herd No. 5,	8	4.49	10.93	2.4
Herd No. 6,	15	4.34	8.59	2.0
Herd No. 7,	8	4.36	10.50	2.4
Herd No. 8,	10	3.12	7.26	2.3
Herd No. 9,	6	4.46	10.42	2.3
Herd No. 10,	10	5.19	14.41	2.8
Herd No. 11,	11	3.87	9.91	2.6
Herd No. 12,	8	4.40	10.71	2.4
Average per cent. fat,		**4.29**	**10.32**	2.4

The average fat content of the milk from the thirteen herds examined was 4.29 per cent., and that of the residual milk 10.32 per cent. The latter figure is 2.4 times as large as the former. The fat content of the mixed herd milk ranged from 3.12 to 5.19 per cent., and that of the after-milk from 7.26 to 14.41 per cent. The lowest figures for milk and after-milk were obtained in the same herd, and this was also the case with the highest figures; as a rule, the fat content of the residual milk follows that of the regular milking; it is generally high when this is high, and low when this is low. This holds true both for milk from single cows and for herd milk. The highest per cent. of fat so far found in a sample of after milk by the writer is 23.0 per cent. (in case of a cow in herd No. 10: the yield of after-milk at this milking was 0.85 pound, and of fat, therefore, 0.20 pound; the regular milking of the cow weighed 11.0 pounds and tested 7.40 per cent.).

It follows from what has just been said that the quality of the milk obtained from a cow or a herd may be improved in a marked manner by addition of the after-milk to the mess of milk secured by the ordinary method of milking, or by adopting the manipulation method of milking, as outlined on pp. 18-21 of this bulletin. In the experiments conducted with our University herd, as well as on outside farms, the results obtained have always been calculated with a view of ascertaining the improvement in the quality of the milk brought about by adding the after-milking to the mess of milk by the ordinary method of milking. The average results arranged for the different herds are shown in the following table:

Improvement in the Quality of Milk Caused by Addition of After-Milking.

	Per Cent. of Fat in Mixed Milk from Whole Herd.		Improvement in fat content, per cent.
	Regular milking.	Residual milk added.	
University herd.	4.12	4.31	.19
Herd No. 1,	4.71	4.92	.21
Herd No. 2,	3.38	3.53	.15
Herd No. 3,	5.08	5.20	.12
Herd No. 4,	4.31	4.49	.18
Herd No. 5,	4.49	4.69	.20
Herd No. 6,	4.34	4.73	.39
Herd No. 7,	4.36	4.88	.52
Herd No. 8,	3.12	3.32	.20
Herd No. 9,	4.46	4.74	.28
Herd No. 10,	5.19	5.78	.59
Herd No. 11,	3.87	4.24	.37
Herd No. 12,	4.40	4.88	.48
	4.29	**4.59**	.30

We notice that the improvement in the fat content of the mixed herd milk for the thirteen herds examined ranged from 0.12 per cent. to 0.59 per cent., and amounted to 0.30 per cent. on the average. This is a striking result, as it would seem, and is, of course, of value to all milk producers who desire a good quality of milk; and it is of special importance where the milk is sold for direct consumption, and is apt to come below a certain standard set, e. g., $3\frac{1}{2}$ or 4 per cent., or must conform to a certain State standard. We have been told that the only way in which mixed herd milk testing below the State standard can be sold, is to add some cows to the herd that produce milk containing a high percentage of fat or to sell off some of those giving milk of a low fat content. The results given in the preceding table show, however, that the dairy farmer has it in his power to increase the percentage of fat in the milk produced by his cows by a simpler and more inexpensive method, viz, through extra care in milking, by taking pains to secure all the milk in the udder of the cow at the time of the milking.

THE SÖNDERGAARD METHOD OF MILKING.

The manipulation method of milking which has been most widely adopted and which was the first one to call attention to the fact that the udder is not completely emptied by ordinary methods of milking, is that perfected by Dr. Hegelund. Another method has been originated and is taught by another Danish teacher of dairy-

ing, Chr. Söndergaard, who has recently described and published his method in pamphlet form.* The Söndergaard method is simpler than the Hegelund method in the different manipulations recommended and may, therefore, appeal to some farmers who would consider the latter too complicated to bother with it. It is a question, however, if it will prove as effective as the latter in bringing down the last drops of milk in the udder at the time of milking. The writer, in commencing this work, decided to make use of the Hegelund method after looking fully into the merits of the two methods, and has had no special cause for going over to the other method later on. Others who take up the Söndergaard method first, might prefer to continue using this method. Briefly stated, the Söndergaard method of milking is as follows:

The milking is done in the ordinary manner, rapidly and with dry hands, the fore and hind teats being milked alternately two or three times. Manipulations are then resorted to in this manner: The right hand grasps the right fore quarter as far up as possible, and the left hand the right hind quarter in the same way, the effort being to get the fingers well in between the two halves of the udder. The hands are then drawn downward toward the teats, pressing the udder at the same time, and the milk brought down is drawn. (See Fig. 6.) The left half of the udder is handled in

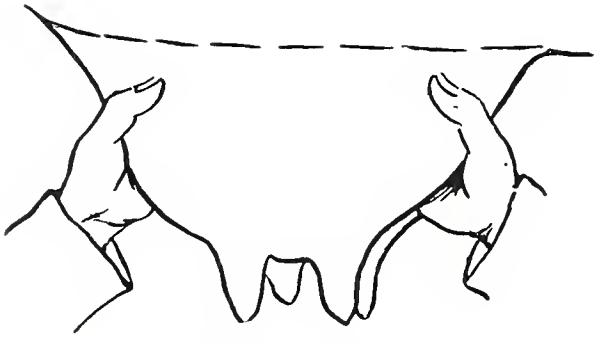

Fig. 6. Manipulation of the Udder by the Söndergaard Method of Milking (Danils.)

about the same way, the thumbs being brought well up between the two halves of the udder and the other fingers pressing against the upper portion of the left half on the outside. The left glands are now pressed against each other, while the hands are moved downward toward the teats. If the udder is very large the manipulations given do not suffice to act on the entire udder, and a somewhat modified manipulation is then resorted to. The hands are placed as in the first case, but the thumbs and other fingers are brought alternately toward each other, so that the skin of the udder lies in a fold, in case of the right half by moving the thumbs

*Den ny Malkemetode, Odense (Denmark), 1901, 66 pp.

toward each other, and in case of the left udder half by moving the other fingers of the two hands toward each other. (See Fig. 7.)

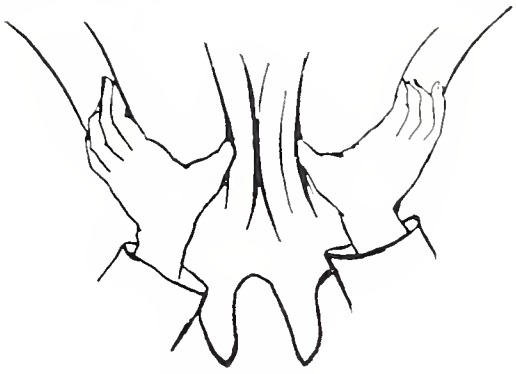

FIG. 7. Manipulation of the Udder by the Söndergaard Method. (Danils.)

In case of both halves the manipulations are continued so long as appreciable amounts of milk are obtained, which will vary with different cows from two to six times.

ON THE IMPORTANCE OF THOROUGH MILKING.

In our discussions so far in regard to the manipulation method of milking, or exhaustive milking methods in general, we have mainly considered the immediate, direct results of such systems of milking, viz., the increase in production obtained and the coincident improvement in quality as far as its fat content is concerned. Important as the direct gain in milk and butter-fat is, it is a question, however, whether other advantages of the method of exhaustive milking are not more far-reaching in their results. Among these advantages, which will presently be considered, are the effect on the persistency of the milking habit of the individual cow and on her offspring, the development of perfect udders and prevention of udder diseases, the prevention of losses through cows holding up their milk and, finally, the influence of a system of careful milking on the milker himself.

EFFECT ON THE PERSISTENCY OF THE MILKING HABIT.

We have had occasion to refer to the tendency toward maintaining a maximum flow of milk throughout the period of lactation, which the thorough emptying of the udder by the manipulation method may be found to possess. It is well known that there is no more certain method of drying off a cow than by leaving considerable milk in her udder for a number of milkings. The milk glands, like all other organs of the animal body, are developed by practice. If the entire secretion of milk in the udder of the cow at the time of milking is not removed and the alveoli thus not thoroughly emptied, they are not stimulated into renewed activity,

and after a while more and more of them will be unable to grow and manufacture milk-producing materials. The complete emptying of all the contents of the alveoli of the milk glands is the best stimulus which these can be given.

This holds good with special force in case of heifers with their first calves and with young cows. The milk glands of these young animals are still in the process of development; by frequent and thorough milkings, half a dozen times a day, if possible, accompanied by liberal feeding, the milk glands are stimulated to great activity and will reach the highest development of which they are capable. Single cases are on record in which claims are made that in some instances it has been possible to nearly double the production of young heifers in the course of a couple of weeks by this method of procedure, even when the frequent milking by the manipulation method was not commenced until they had apparently reached their maximum yields.

Dr. Hegelund thus states that the daily milk yield of a cow was increased during the first three weeks after calving from between 11 and 14 pounds to 33 pounds, by milking seven to eight times a day; another cow was raised from 8 to 23 pounds, and a third cow from 20 to 38½ pounds. The last heifer was two months from calving when they began to milk her by the Hegelund method, and in six days she gave over 38 pounds of milk a day, and after three and one-half months still produced over 32 pounds.* In all cases the cows kept up the high flow of milk when they were again milked the regular three times a day, as in the case of other fresh milkers. A similar experience is furnished by the Austrian dairy instructor, Alfonsus.† A party had agreed to buy a cow of a farmer at a certain price, if she gave 45 pounds of milk a day when she came in. It turned out that she gave only 36 pounds after calving, however; he was advised to practice milking the cow every two hours for some time, and after only a few days the flow of milk had been brought up so that she yielded over 48 pounds a day when she was again milked three times a day.

The only other reference to the effect of frequent milkings in case of fresh heifers or young cows in the dairy literature which has come to my notice, is from Switzerland and is reported by T. Waldvogel.‡. Three Swiss dairy farmers who were greatly interested in this question began systematic six-times-a-day milking with young and poor milkers in their herds. In two cases the results obtained were good so that the extra work soon paid, while in the third case negative results were obtained, since the yield soon dropped to its former level.

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*Danils, Om Mjölkning, p. 35.
†Loc. cit., p. 10.
‡Forschungen auf d. Geb. d. Landw., Kraemer, 1902, p. 52. See also Ber. Physiol. Labor., Univ. Halle (J. Kühn) VIII, 1891, p. 18.

These examples come from countries where a Babcock test or a similar method of fat determination is not the necessary and common adjunct on every modern dairy farm, so we are left to surmise how the quality of the milk changed with the increase in flow, and in the absence of such data breeders and other who feel disposed to experiment along the line suggested should be on the lookout for accurate information, also, as to the possible increase in the production of fat resulting from the frequent milkings.

The instances referred to above are not sufficiently numerous, nor can the results be considered of such a character as to furnish conclusive proof of the advantage of frequent exhaustive milkings during the early part of the lactation period; still they are promising and suggest that the secretion of the milk glands may be greatly increased through the stimulus of frequent milking in case of fresh cows, and particularly in heifers with their first calves, whose udders are most capable of further development. A cautioning word is perhaps in order in addition to what has been said. The frequent milking must not be carried too far or continued too long. The constitutional strength of the cow determines how far she can be pushed. Overtraining is as apt to occur in stimulating milch cows as in developing athletes. A liberal system of feeding is especially important at times of great production, and the feed offered should contain a liberal supply of easily digestible concentrated feeding stuffs.

The tendency of some cows to dry off early may also be checked through adoption of the manipulation method of milking. This is only what might be expected and depends on well-known laws of physiology. We see the effect of the opposite practice illustrated in the brief lactation periods of beef cows whose udders are not emptied completely by the nursing calf or calves, or of cows that are milked carelessly.* Hegelund makes note of a cow which was dry four months from the time of calving one year, and the next gave over thirty-eight pounds of milk at the same time from calving, when she had been milked by the manipulation method.†

EFFECT ON THE OFFSPRING.

Another advantage of the manipulation method of milking lies in the effect on the offspring of developing a high productive capacity in the cow. According to a well-recognized law of heredity, like begets like; a dairy cow whose milk-producing capacity has been developed to its greatest perfection will be likely to transmit this quality to her progeny, and these will be large and persistent milkers and valuable dairy cows according to the extent to which the faculties of the dam for transforming plant materials into

*Menzel, Milch Secretion Keine Raceeigenschaft, p. 124.
†Danils, loc cit., p. 35.

milk and butter-fat have been developed. It is only by gradually raising the standard of production that further development in the dairy herd is possible. The dairy cow who has been handled so as to reach her highest capacity as a producer will have calves that, in turn, are capable of the highest development.

EFFECT ON THE DEVELOPMENT OF PERFECT UDDERS.

A critical examination of the udders of the cows in most dairy herds will disclose the fact that a very large proportion of our cows have unsymmetrical udders; in one cow one quarter is gone or poorly developed; in others, another quarter; the front development of the udder is often deficient, and in a majority of cows the right half of the udder is better developed than the left half. The cause of the unevenness may, in many cases, be traced directly to the methods of milking practiced; if all four quarters be always milked completely dry and handled evenly, they will develop uniformly, and a well-balanced udder will be the result, where hereditary influences do not enter in. In the latter case, more attention should be given to the portion of the udder that is likely to be deficient, so as to counterbalance this tendency. The proper handling of the udder is a potent factor in the development of even, perfectly balanced udders.

EFFECT ON PREVENTION OF UDDER DISEASES.

A system of careful and exhaustive milking is also an important factor in preventing diseases of the udder. The losses which our dairy industry sustains through defective udders or a diseased conditions of these are larger than many suspect. Inflammation of the udder is by no means an unusual occurrence on the dairy farm. It generally comes after calving, at a time when the flow of milk is nearly at its highest, or when the cow is being dried off. While it usually yields to treatment after a short time, it often leaves behind uneven quarters and one or more teats that do not give milk. If the inflammation did not spread to the whole quarter, this will give normal milk again when the gland has recovered, but the yield from the quarter will be smaller than usual and the production of the cow for the year thereby reduced. This reduction may amount to a large percentage of the total yield of the cow for the year. The variations in the yield of milk from many cows from year to year are doubtless often traceable to this one cause.

When inflammation of the udder manifests itself by a hard caked condition of one or more quarters and an abnormal secretion of milk, the best preventive is to empty the milk of the diseased part thoroughly and often, say every hour. The udder is thus completely and in as short time as possible freed from the bacteria which give rise to the inflammation, and is generally restored to a healthy condition and to normal milk secretion within a few days. The

milker should watch his cows carefully and take pains to remove at once from the udder milk of abnormal appearance containing fine cheesy matter, by frequent and exhaustive milking (including manipulations); he may thereby stop the inflammation while it is still in its early stages and thus save the owner considerable losses of milk and possibly save a cow for the dairy. Milk of the character mentioned is not fit for direct consumption or for the manufacture of butter or cheese, and should be thrown away outside of the stable, or sterilized and fed to young stock. (See, also, p. 82.) It should not be milked on to the stable floor or into the manure gutter so as not to spread contagion, nor added to the milk from healthy cows, as it may render the whole mess of milk unfit for the manufacture of dairy products.

EFFECT ON COWS HOLDING UP THEIR MILK.

Cows sometimes do not let down all of the milk in the udder at a milking, through a congestion of blood in the veins or the arteries of the udder, which closes the sphincter muscles at the branching points of the various milk ducts in the udder. We have repeatedly found, while conducting the investigations reported in the preceding, that a cow can not, as a rule, continue to hold up her milk after a few manipulations of the udder have been practiced. When a cow does not give her usual mess of milk and there is no reason to suspect that she is sick, she is very likely holding up her milk, and in such case it is especially important to finish up the milking by the manipulation method. This will generally give the owner about the usual amount of milk from the cow and will leave the milk-secreting glands of the udder in proper condition for the manufacture of milk for the next milking. It is true that when a cow refuses to give down her regular mess of milk at a milking, the yield at the next milking will most likely be considerably increased, but she will rarely make up the whole deficiency ,and for her own comfort, as well because she will do her best when the milk secretion goes on in the regular manner, without great variations, she should be made to give down all the milk in her udder whenever milking time comes around, if she does not choose to do so of her own accord, as is ordinarily the case.

INFLUENCE ON THE MILKER.

We notice how the work of the milker becomes more and more important in view of these considerations, and as the importance of the work is more appreciated and a better understanding of the wonderful processes of milk elaboration is gained, the persons doing the work will be more highly respected and will themselves look upon the milking with other eyes. The milker will know

that each cow will only give down all the milk she has when he does his work conscientiously and never allows himself to abuse the cow in any way, and that unless he does his work well, the result will not only be an immediate, direct loss of milk, both as regards the quantity and the quality of the production, but an indirect one, which may make itself felt throughout the whole period of lactation and permanently decrease the value of the cow as a dairy animal. It is one of the credit marks which belong to the manipulation method of milking that it has brought the importance of the work of the milker prominently into the foreground.

THE DIFFERENCE IN MILKERS.

It was stated in the discussion of the results of the milking experiment with cows in the University herd (p. 32), that the variations in the increase in the production of milk and butter-fat by individual cows secured by the manipulation method are largely traceable to differences in the character of the work done by the different milkers. We shall now examine into this matter somewhat more in detail. If the percentage increase in fat production and the absolute amounts of milk and fat obtained in the after-milking from the different cows on the experiment be grouped according to the milker, we have the following statement:

Results Obtained by Different Milkers on Main Experiment.

Milker No.	Name of Cow.	Residual		Increase of Fat.
		Milk per day.	Fat per day.	
		Lbs.	Lbs.	Per cent.
I,	Mollie,	.81	.06	8.1
	Joe,	1.64	.08	10.8
	Chloe,	1.42	.10	10.3
	Belle,	1.71	.10	12.4
	Muriel,	1.36	.15	14.2
	Mary,	1.55	.14	30.2
	June,	.60	.05	8.2
	Dorine,	1.24	.15	13.3
	Average,	1.29	.10	13.4
II,	Maud,	.58	.04	3.0
	Alma,	1.48	.06	7.5
	Pauline,	.65	.05	5.3
	McGeoch,	.88	.06	4.2
	Lady,	1.13	.10	11.2
	Gold,	1.03	.10	7.6
	Rilma,	1.09	.13	13.8
	Elsie,	1.32	.12	16.9
	Average,	1.02	.08	8.7
III,	Ella,	.79	.09	7.1
	Bessie,	1.09	.10	14.3
	Laura,	.41	.03	4.4
	Dixie,	.39	.03	5.6
	Brownie,	.80	.08	10.4
	Dora,	.52	.05	4.5
	Donation,	.55	.04	4.0
	Reba,	1.03	.11	9.0
	Princess,	.54	.05	8.7
	Average,	.72	.07	7.8
	Percentage difference between I and III,	44	30	.....

The figures given in the table represent average data for the different cows for a period of four weeks (week 3 of the experiment not being included therein); it is self-evident that much greater differences between the milkers would be likely to occur, if data for a few milkings or only a single milking are considered. None of the attendants who milked the cows on this experiment could be called poor milkers, except, perhaps, No. I, and still there is an extreme average difference between them of over one-half of a pound of residual milk, and .03 of a pound of residual fat (44 and 30 per cent., respectively).

The milkers were not changed during the experiment, but determinations of the amounts of residual milk and fat in case of different cows have been made at different times during the past half year, when the same cows have been milked by different milkers. The data on this point available with cows in our University herd are given in the following table, which shows at a glance the amount of fat obtained in the after-milking with the same cows when milked by different milkers. The milkers designated as I-III in this table are the same as those of the same number in the preceding table.

Average Amounts of Fat in After-Milk Left by Milkers I-V, Per Day.

Name of Cow.	I.	II.	III.	IV.	V.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
1. Mollie,	.06	.06			
2. Muriel,	.15	.14			
3. Dorine,	.15	.09		.21	
4. Mary,	.15			.08	
5. Chloe,	.10			.27	.05
6. Belle,	.24, .10				.04
7. June,	.11, .05				.03
8. Joe,	.08				.02
9. Laura,		.14	.03		
10. Brownie,		.10	.08	.07	
11. Alma,		.07		.14, .11	
12. Donation,		.09		.04	
13. Rilma,		.13			.05
14. Dora,			.05	.08	
15. Bessie,			.10	.13	
16. Princess,			.05	.07	
17. Ella,			.09	.17	
18. Dixie,			.03		.02
Average,	.12	.10	.06	.13	.04

Differences greater than two-tenths of a pound of fat are found three times in this table, and differences of one-tenth of a pound occur often in case of single cows. The greatest difference in the averages for the individual milkers is nine-hundredths of a pound, or nearly one-tenth. A difference in the daily production of fat of one-tenth of a pound would mean one pound for every ten cows;

at twenty-five cents a pound for butter-fat, the best milker would, therefore, increase the returns from the dairy by twenty-five cents every day per ten cows; that is, he would be worth at least $7.50 a month more to the owner of the herd than the milker leaving most milk in the udder.

Still greater differences between individual milkers were found in the tests of cows in herd No. 6 (see p. 41). If the amounts of fat in the after-milking left by the different milkers on this test be averaged, we have the following figures:

Milker I left .17 pound of butter-fat per cow in the after-milk.

Milker II left .05 pound.

Milker III left .19 pound.

Milker IV left .20 pound.

The difference between the best and the poorest milker in this herd, therefore, amounted to .15 pound of butter-fat per herd per day. If we assume that one milker milks fifteen cows, as is the case on many dairy farms, and that the cows give milk 300 days in the year, this difference, if continued throughout the lactation period, as it would be apt to do, would mean an annual loss to the owner of 675 pounds of butter fat, worth $169 at twenty-five cents a pound; that is, the owner could well afford to pay the one milker fourteen dollars a month higher wages than the other, when only the immediate, direct loss is considered. But, as has been previously suggested, the influence of a good milker may extend beyond this result; a better flow of milk is apt to be maintained by careful milking and the dairy cow whose productive capacity has thus been increased to her highest ability, will be likely to give this improved power of production to her offspring, thereby increasing the yield of dairy products for generations to come.

The average quantities of milk obtained in this herd by the manipulation method were as follows: With the cows milked by milker I, 2.5 pounds; by milker II, .63 pound; by milker III, 2.3 pounds, and by milker IV, 2.1 pounds, per cow per day. Data presented under herds Nos. 3 and 9, as well as in discussing the results obtained with cows in our University herd, show that when cows are milked perfectly clean, the after-milking will not ordinarily exceed one-half of a pound of milk per head daily, so that it is evident that even the work of the best milker in this herd could be improved upon.

COMPARISONS OF THE WORK OF THE SAME MILKERS.

Not only do different milkers leave different amounts of milk in the udders of the same cows, but the same milker does his work more or less carefully at different times, according to how crowded he is with other work, or thinks he is, according to how much he

is interested in the work of milking at the time, or whether he feels that he is watched or not. A number of determinations of residual fat with cows in our University herd that were milked by the same milker, are at hand, which will illustrate the correctness of this statement. Milker No. II left .09 pound of residual fat, on the average, for eight cows, June 10-18; .07 pound, July 2-9, and .11 pound, August 10-19 (average for five cows); an extreme average difference of four-hundredths of a pound, or a pound of butter-fat a day from twenty-five cows.

THE MILKING PROBLEM.

One of the most serious problems with which the dairy farmer has to grapple to-day is that of getting reliable milkers. In many parts of this country, as in fact in foreign dairy countries as well, it is generally difficult to get milkers at all, to say nothing about good milkers. This difficulty is, perhaps, less chronic in dairy sections than in regions where only few farmers are specialized dairymen, or keep more cows than needed for family use; but it is true in either case that many farmers are kept from going into dairying because of the difficulty of the labor problem on the dairy farm, and others do not keep as many cows as they would otherwise do for the same reason.

The objection will, no doubt, be raised to giving more time and attention to the work of milking than is now the case, that it is hard enough to get the work done as it is. If the conclusions drawn from the investigations described in this bulletin are correct, however, the yield of milk from our dairy cows can be permanently increased by about 12 per cent., by a system of exhaustive milking, as provided for by the so-called manipulation method, i. e., eight cows can be made to yield as much as nine do now. This would not require any more time for the work of milking than is now given to it, if the milker practices the manipulations as soon as a full flow of milk has ceased, and would mean a saving of feed, an investment of a smaller capital and smaller business risks. It will pay better to keep a smaller number of cows than a some what larger one, if both lots are capable of a similar production.

SUGGESTIONS AS TO THE SOLUTION OF THE MILKING PROBLEM.

The question how the difficulty of securing competent milkers on the dairy farm and elsewhere may be overcome, is a very timely one. The use of machines for doing the work of the milker will be discussed below. We shall here consider some ways by which the milking problem on the farm may be solved without the

aid of machines, even if such were entirely satisfactory and practical at the present time. As a first suggestion which would tend to dignify the work of the milker, we would say that when the work is more appreciated than is now often the case, it will have more attraction for bright, intelligent young men, and older ones as well. Instead of looking upon the work of milking as a necessary evil and a drudgery, it should be classed among the most important work on the dairy farm, and the milker should, therefore, be considered as holding a position of responsibility, as is also, without a doubt, the case. For the work of milking, as we have seen, calls for an intelligent exercise of qualities which by no means are the inheritance of all farm hands; like the poets, the good milker is born, not made, and unless a man is naturally to some extent gentle, conscientious and observing, the chances are that he will never make a good milker.

If the owner himself milks some of the cows he has a good opportunity to show by his personal conduct how he regards the work of milking; a good example is worth any amount of preaching. The fact that the milking can easily be done very poorly, for a time at least, if the milker is so disposed, without being directly apparent, renders it doubly important to have reliable men for this work.

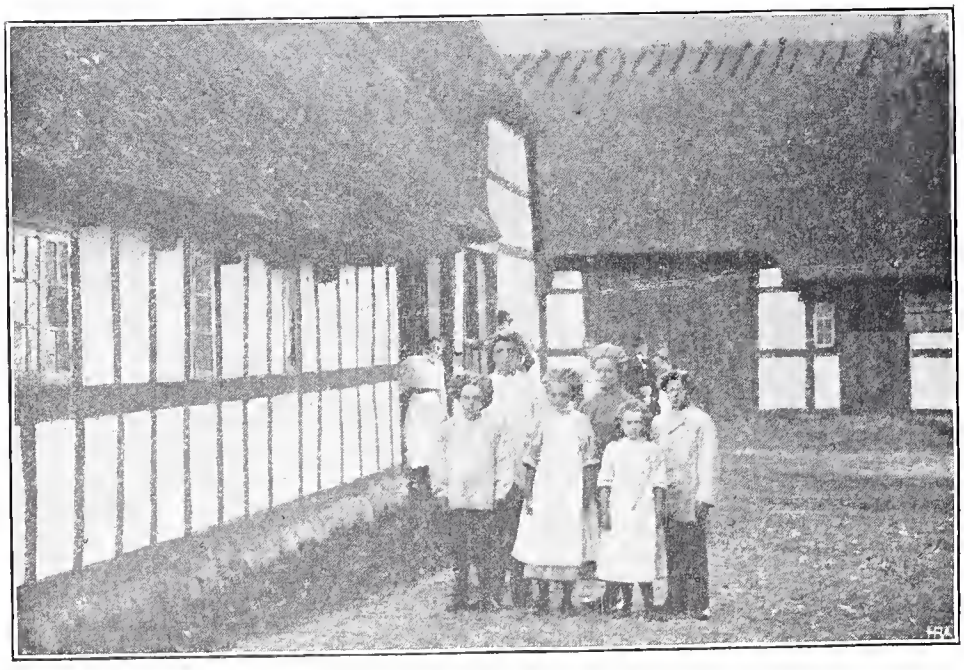

Fig. 8. A Group of Young Danish Milkers. (Söndergaard.)

Next to the owner taking part in the milking himself, it will have a good influence if the children are taught to milk at an early age, and have certain cows in the herd assigned to them. Fig. 8 shows

a group of young Danish milkers who are "broken in;" they have gone through the special course for milkers and are ready to begin their work. It is not difficult to see that when an interest in cows and milking is awakened at this young age, and they are started with the right method of milking, a habit of careful, thorough milking may readily be formed which will stay by them for the rest of their lives.

WAGES OF THE MILKER.

We have seen that one milker in one of the herds examined in the investigations here reported was worth at least $14.00 a month more to the owner than another, from the larger amounts of milk and butter-fat he obtained from his cows. This being so, the dairy farmer can well afford and should be willing to pay higher wages to a good milker. A good milker is a valuable man and he should be enabled to feel the money value of the appreciation which is due him.

PRIZES FOR MILKING.

Another way by which greater interest in the work of milking may be awakened is to give prizes for the best milkers in the herd, or to pay according to the amount of milk drawn. Either plan would render it necessary to weigh the milk at every milking, or at certain intervals, e. g., every three days, once every week or ten days, as is now done on some dairy farms. The plan of weighing and recording the milk of each cow every milking is much to be preferred, and is no laborious undertaking if a spring balance is used and is hung conveniently near a milk record sheet. The weighing and recording will, under such conditions, hardly take a minute's extra time. Such a milk scale (see Fig. 9) costs $3.65 retail, and is a good investment on any dairy farm and it will soon pay for itself through the greater care in milking which it will inevitably bring about. If certain cows are assigned to the different milkers, giving each one an equal share of fresh cows, young heifers and strippers, the quantity of milk to be credited to each milker may be readily ascertained, and either prizes or regular pay given accordingly.

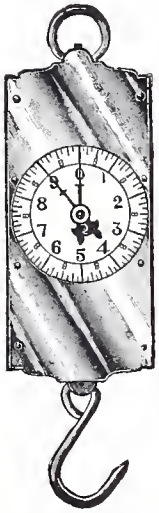

FIG. 9. A convenient Milk Scale.

On large European dairy farms it is quite common to contract out the milking to women or married people living in the immediate neighborhood, at a certain price per hundred pounds of milk, say 6-8 cents on the average. At one Danish estate the milking is

thus paid for according to the following schedule of prices per hundred pounds of milk: From mature cows, 4 cents, from heifers, 7 cents, and from strippers, 8 cents; in addition a prize of about $2.00 is given if a cow yields 12 pounds of milk more three months before calving.*

In this country the wages paid to milkers are, of course, higher than in Europe and the work of milking is paid for at the rate of 10 to 20 cents per hour. If we assume that a good milker will milk about 80 pounds of milk an hour,† a price of, say, a shilling an hour for milking, which may be considered an average figure for the Eastern and Central States, will be equivalent to slightly above 15 cents per hundred pounds of milk.. Where cows of different breeds are found in the same herd, the credits for milking are preferably based on the production of fat instead of on that of milk. In large, well-regulated dairies this can be readily done, since tests of the milk from single cows are made regularly every month. This system means increased work for the book-keeper, but it insures a fair remuneration for the work of milking and gives an incentive to careful, exhaustive milking, which will amply pay for the extra trouble and will be fully as much to the advantage to the owner of the herd as to the milkers.

In some European dairy countries, e. g., in Denmark and Sweden, prizes are offered for the best milkers in connection with agricultural fairs or county agricultural societies offer such prizes. This is a good method of stimulating interest in the work, and will suggest to the minds of many young men that there are opportunities for reaching excellence and for making a reputation in this work, as in other professions that we hear more about.

IMPROVEMENT IN THE CONDITIONS OF THE MILKER.

The work of the milker may also be dignified by making the cow stable an agreeable place to work in. All farmers cannot have large, well-lighted and well-ventilated stables, with patent iron stalls, cement floors and gutters, etc., but cows should not be placed in a stable that cannot be kept clean and is not cleaned out regularly every day. The use of land plaster and some absorbent, like cut or shredded corn stalks, shavings or peat litter, for keeping the air in the stable sweet and pure, is inexpensive and its use highly to be recommended. A banquet was recently held in the cow stable of the Illinois Experiment Station.‡ It is unfortunately a fact that there are but comparatively few cow stables where people

*Landmandsblade, 1902, p. 56.
†Fleischmann, Lehrb. d. Milchwirthschaft, 3d ed., p. 85; Martiny, Prüf. d. Thistle-Melkmaschine, p. 62.
‡See Ill. Experiment Station Bulletin No. 84.

who are accustomed to eat good, neatly served food, would want to take a meal, but the nearer we come to such a condition the more pleasant the work of tending and milking the cows will be.

Dairy farmers should always bear in mind that they are producing an article of food intended for human consumption, either as milk or as butter, cream or cheese. The greatest care should be taken to obtain a high grade of products. For this reason the milkers on many large dairy farms wear a clean, white suit when they do the milking (see Fig. 10); they also wash their hands before

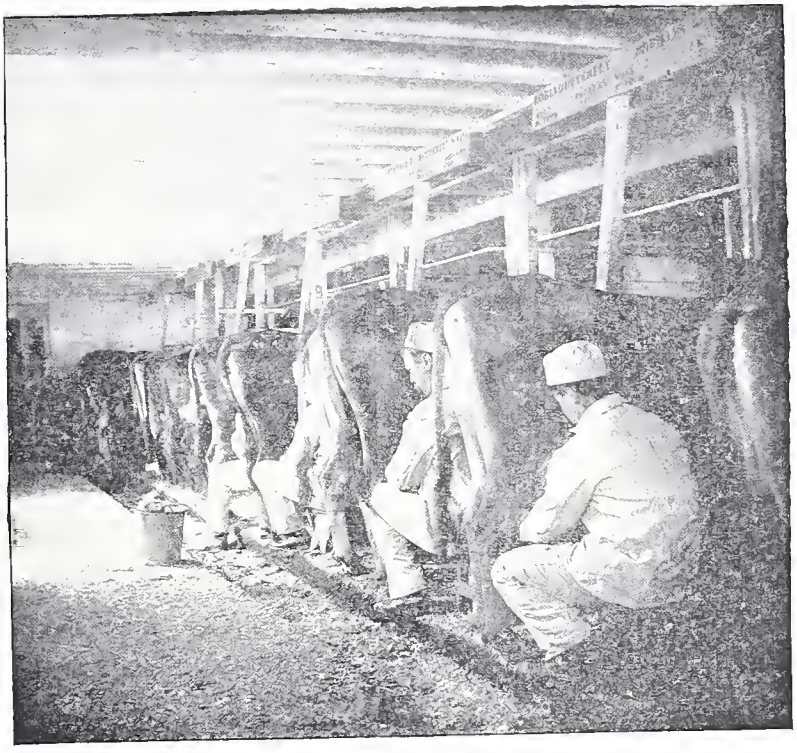

Fig. 10. Milking in a Modern Cowstable. (Stocking.)

starting the work and brush off the udders of the cows as they sit down to milk, using a clean rag for this purpose or a stiff brush. Since the first few streams of milk contain a large number of bacteria and is, moreover, very low in fat content, they are generally thrown away, being either milked on to the floor or into the gutter, or, better still, milked into a small cup (see Fig. 11). The milk is always strained directly after milking, to free it from particles of food stuffs, litter, or other matter than may have dropped into the pail during the process of milking. A covered milk pail is used at a number of dairy farms which supply so-called certified milk; the milk passes through a layer of absorbent cotton as drawn from the udder, which prevents the particles of the kinds men-

tioned from falling into the milk. As a result such milk will contain smaller amount of impurities and fewer bacteria than milk

FIG. 11. The Covered Milkpail in the Stable; the First Jets From Each Quarter of the Udder are Drawn Into a Cup and Discarded. (Stocking.)

milked into an ordinary open pail, and it will be likely to keep fresh for a longer period of time.* It is a purer article of food

FIG. 12a The Gurler Sanitary Milkpail.

than milk obtained in the ordinary way, for no matter how carefully this has been strained it is always better to keep the impuri-

*Storrs Agr. Experiment Station, Bulletin No. 25.

ties out altogether, if possible, than to strain them out afterwards. Figs. 12-13 show two forms of covered milk pails, with the separate parts of the Gurler sanitary pail.

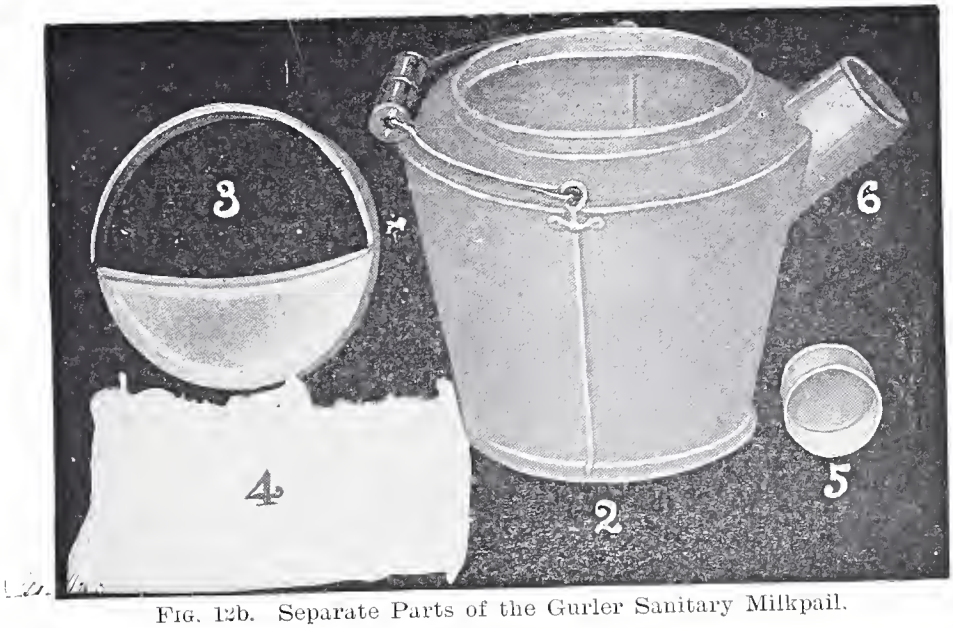

FIG. 12b. Separate Parts of the Gurler Sanitary Milkpail.

All the precautions mentioned cannot be observed at all dairy farms, but they are the ideals towards which one must strive if

FIG. 13. The Stadtmuller Covered Milkpail.

progress is to be made. It goes almost without saying that where conditions exist like those suggested, the work of milking is looked

upon as a most important one, and there is a great incentive to do good work. When facilities like those described above are offered and required to be used, it will have a wholesome influence upon the milkers, and these are likely to feel the dignity and importance of their labor, as is not possible on farms where no particular attention is paid to securing products of high quality and where the work is done in a perfunctory manner, at any time almost when other farm work is out of the way.

MILKING MACHINES.

The problem of getting the milking done on the farm would lose much of its importance if it could be done by means of a machine instead of by hand labor, thus rendering the work of milking easier and reducing the necessary hired help on the dairy farm. Ever since dairying became a separate industry the subject of milking machines has been prominently before inventors of an agricultural turn of mind, and "many a time and oft" it has been confidently hoped that the problem had been solved. Milking machines said to have been in successful operation for a season or more in one or several herds have repeatedly been brought out, and the inventor, as well as the dairy public, seemed justified in their expectations of the success of the machine. After a year or two nothing more was, as a rule, heard of the machines, however, and the presumption is that they fell short of being a practical machine in some vital point. We shall mention briefly the main ones of the candidates for favor that have been presented during the past twenty years or more, and shall reserve for a somewhat fuller discussion the few machines on the market at the present time, two of which, at least, bear promise of filling the long-felt want of a satisfactory practical milking machine.

FIRST ATTEMPTS.

The first attempts to replace the human hand in drawing the milk from cows by a machine or a mechanical device of some kind date from 1836, when milking tubes were patented in England for this purpose.* Such tubes had previously, in fact as long as cows have been kept for the use of man, been employed to draw milk from diseased teats. About a quarter of a century later—in 1862—the first milking machine proper developed from this simple beginning, suction being applied in connection with milking tubes. This was the machine of Kershaw and Colvin. Since that time milking tubes have repeatedly been placed on the market for use

*Martiny, Die Milch, I. p. 70.

in milking cows, even quite recently when the "Perfect Automatic Cow-Milker Company," of Buffalo, N. Y., took out a patent for their use for this purpose.*

As is nearly always the case, this beginning was very crude, and the method was never, so far as known, adopted as the regular every-day method of milking a herd of cows. But numerous other machines have, from time to time, been brought forward for this purpose, some of which depend on suction, others on pressure, or on both. The German dairy writer, Dr. B. Martiny, in his report on trials of the Thistle milking machine, by the German Agricultural Society in 1898, referred to above, gives a bibliography of this question, and a list of twenty-nine different milking machines known to him, which had been patented in different countries or mentioned in the dairy literature between the years 1877 and 1898. In this list a few American machines are also included. On referring to the Annual Reports of the U. S. Commissioner of Patents, it will be found that during the period of thirty years, from 1872 to 1901, inclusive, ninety-eight patents were taken out in this country alone for milking machines of various kinds, or some separate parts of them. These patents were granted to over seventy different inventors, showing that a large amount of study and inventive genius has been directed toward the solution of the problem of a mechanical milking apparatus. The large number of machines that have been patented in themselves bear evidence of the difficulty of the problem. Because the older machines do not appear to meet the demand of an efficient and practical cow-milker, new ones are all the time coming up, and in their turn have to give place to new candidates for favor. The root of the difficulty lies in the fact that cows are living beings, differing greatly from one another in general disposition and conformation of the udder, as well as in the treatment to which they have become accustomed. The cow is a mother, and the secretion of milk is a material function. The human hand, with its touch and handling of the udder has more of the peculiar influence on the cow that the suckling calf has than any machine is likely to have. While it does not seem probable, therefore, that the milking can ever be done as satisfactorily by means of a machine as by the hands of a conscientious, good milker, it is nevertheless true that the mechanism of milking machines has now been so perfected as to very closely imitate the manner in which the calf sucks, and according to present prospects the time may be near when a milking machine will prove a practical success. Such an event will mark a new era in dairying and will rank in importance with the invention of the continuous cream separator, and the Babcock and similar rapid and practical tests for determining the fat content of milk and other dairy products.

*Martiny, Prüf. d. Thistle-Melkmaschine, p. 115.

OLDER MILKING MACHINES.

Of the older milking machines that came to have some importance and for a time, at least, appeared to work satisfactorily, may be mentioned the Cushman machine (U. S. patents Nos. 594,860, 579,339 and 654,091), the Thistle machine (U. S. patents, in the name of A. Shields, Nos. 513, 624-5, 524,738, 556,217, 557,241, 558,666 and 654,331), the Murchland machine (U. S. patents Nos. 473, 770, 501, 804), the DeLaval Lactator (U. S. patents Nos. 544,813, 548,836 and 574,357), and the Wright cow-milker. A few remarks may be of interest in regard to these machines.

The *Cushman milking machine* originated in Iowa; inventor, M. J. Cushman, Waterloo, Iowa. It was often spoken of in the nineties, but during late years nothing has been heard of it, and it is not known whether it is manufactured or in use in any dairy herd at the present time.

The *Thistle machine* (see Figs. 14 and 15) originated in Scotland, and was put on the market by the Thistle Mechanical Milking-Machine Company of Glasgow. This machine, which works by inter-

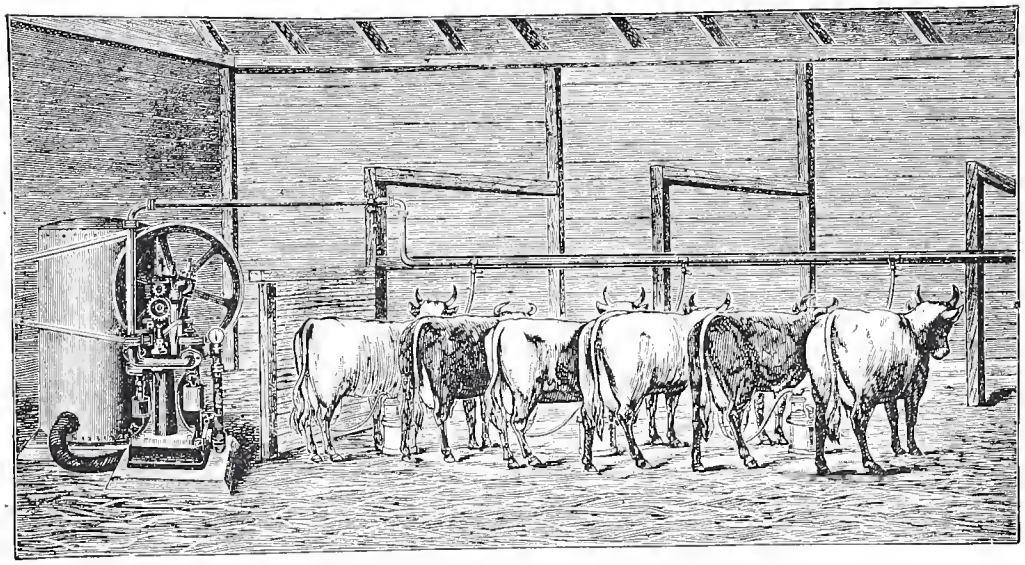

FIG. 14. The Thistle Milking Machine Installed in a Dairy Barn.

mittent suction, has been in use in dairy herds in Scotland and on the continent in Europe for a number of years past, and also in some American herds, having been introduced here from Canada. In 1898 Dr. Martiny found that eighteen of these machines had been installed on German dairy farms, of which number eight were taken out after a period of time ranging from a few days to one-half year. The writer, in 1901, visited a dairy farm near Göttingen, Germany, where a machine of this kind had been in successful opera-

tion for a year and a half. The opportunity for getting power was exceptionally favorable at this estate, since a good-sized stream ran through the farm, furnishing ample power for generating electricity, by which means dynamos were run, light was furnished and all kinds of farm operations done. The owner followed the system known to Germans as *Abmelkwirtschaft* in running his dairy of some seventy cows, i. e., buying fresh cows and disposing of them again when they were dry, after about eight months, on

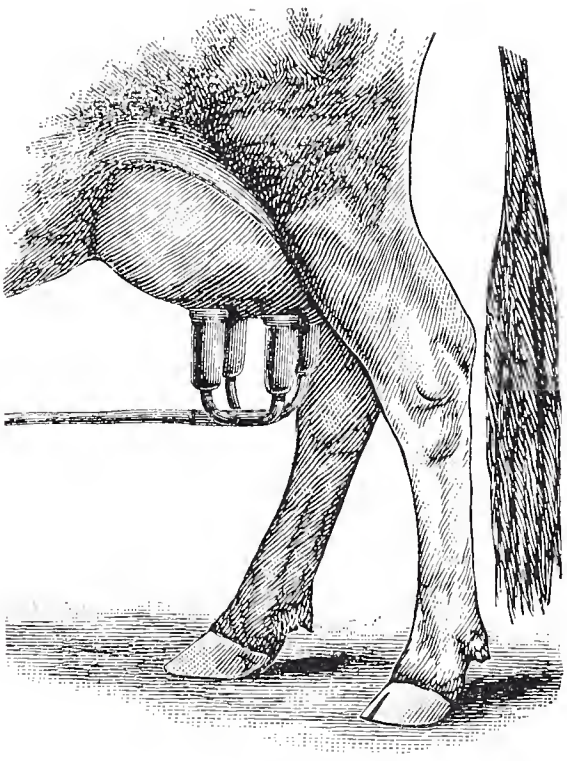

Fig. 15. Teat Cups of Thistle Milking Machine.

the average. The success of the milking machine under these conditions cannot, of course, be taken as evidence that it would prove a good machine for the dairyman who raises his own cows, to whom, therefore, the persistency of the milk flow is a factor of prime importance. In the dairy mentioned, sixty-six cows were milked by three men by the aid of a machine, run by a seven horse-power dynamo; the milking had been done by six girls prior to the installation of the machine. The machine left three to four liters (quarts) at a milking from the whole herd to be milked out by hand, and the tendency among the men was evidently not to go over the cows and milk them perfectly clean after the machine had gotten all the cows would give down.

A thorough investigation of the merits of the Thistle machine was, as previously suggested, conducted by Dr. Martiny, under the auspices of the German Agricultural Society, in 1898, the results

of which are given in the report referred to above. The conclusions on this investigation are interesting from the fact that they treat the subject broadly and apply to the better kinds of milking machines with equal strength. A few extracts of the summary of the conclusions are given here:*

"The installation of the machine on farms offers none or only small difficulties, either so far as the hired help or as the cows themselves are concerned. The supervision of the work of milking, with all the necessary apparatus, is considerably more difficult and exacting with machine milking than by hand milking. When properly conducted, the milk and other products do not differ in quality whether the milking be done by machine or by hand. The health of the cows did not suffer in any way on account of the machine milking; on the contrary, diseases of the udder seemed to occur less frequently than in the case of hand milking. The capital invested is increased by about thirty marks or more ($7.50) per head by machine milking; the running expenses for the work of milking are, however, easily reduced below the cost of hand milking. The machine saves about 60 per cent. in hired help, but it raises materially the requirements for the attendants in point of cleanliness, watchfulness and care. Machine milking is, briefly stated, at the present time mainly to be looked upon as a makeshift."

During late years very little mention has been made in our dairy literature concerning either this machine or the next one enumerated above, the Murchland machine. The latter machine, which, like the Thistle, comes to us from Scotland (inventor, W. Murchland, Glasgow), competed with the Thistle for prizes at the Glasgow Agricultural Show in 1887, and was awarded the first prize of £50. The judges visited three farms where the Murchland machine was seen in successful operation, of which one had used it for six years, while the Thistle was seen in operation on four farms. The keeping quality of the milk drawn by the Murchland machine was much better than that obtained with the Thistle machine; in some cases milk drawn by the latter machine soured in twelve to fourteen hours, and had a disagreeable flavor, while milk drawn by ordinary hand milking under similar conditions would keep perfectly sweet for thirty-six to forty hours.†

The *DeLaval Lactator* (see Figs. 16 and 17) is a Swedish milking machine, invented by G. DeLavel, of separator fame. It is perhaps the most ingenious, and in its construction, the most complicated milking machine yet brought out, so far as can be judged from the published descriptions and illustrations of the various machines. The Lactator was described by the writer in 1896, after a visit to the experimental farm of Lilla Ursvik (near Stockholm, Sweden), owned

*Loc. cit., pp. 113-114.
†Transact. Highland and Agr. Society of Scotland, X, pp. 166 and 507.

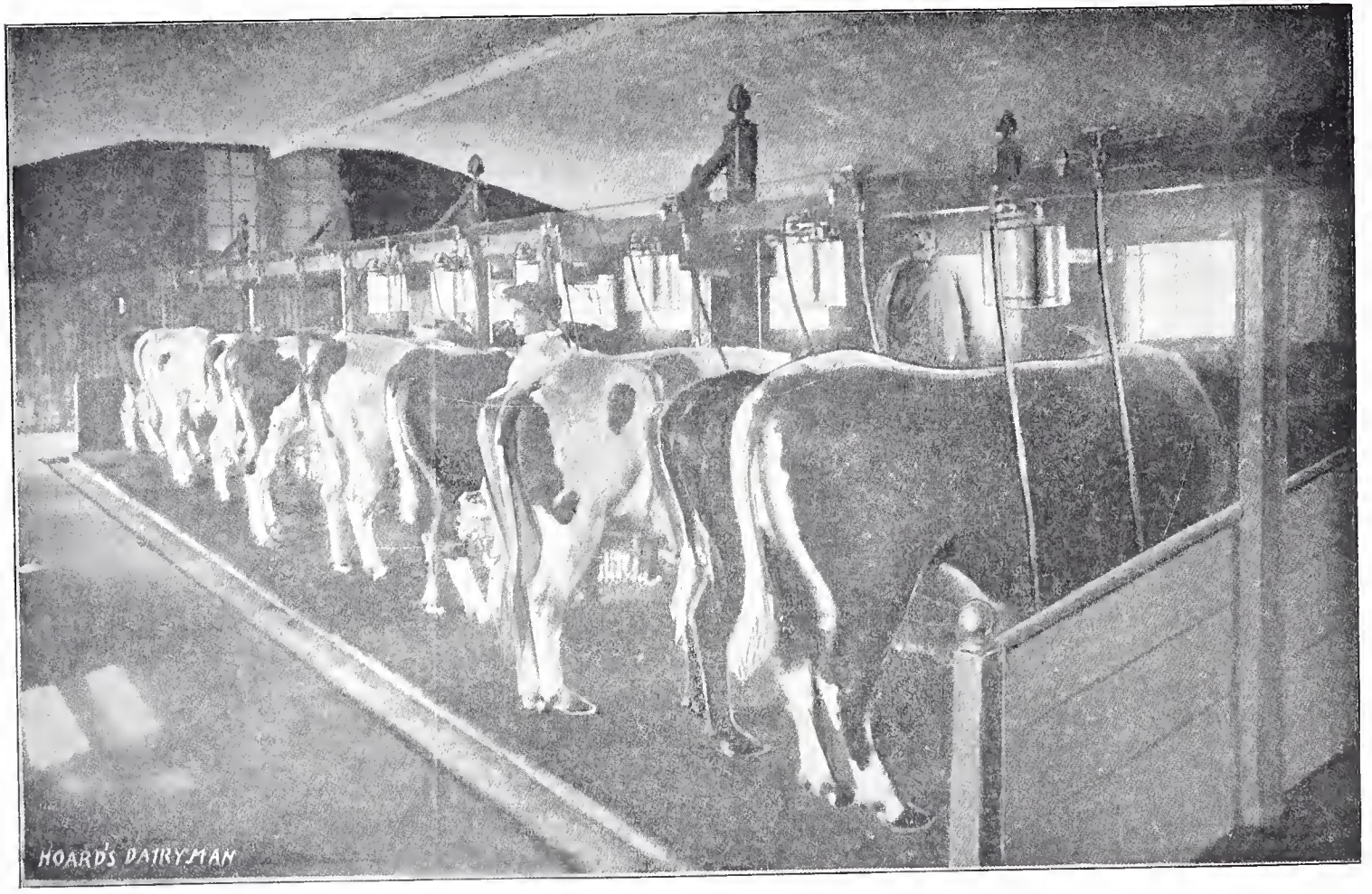

FIG. 16. The DeLaval Lactator in Operation.

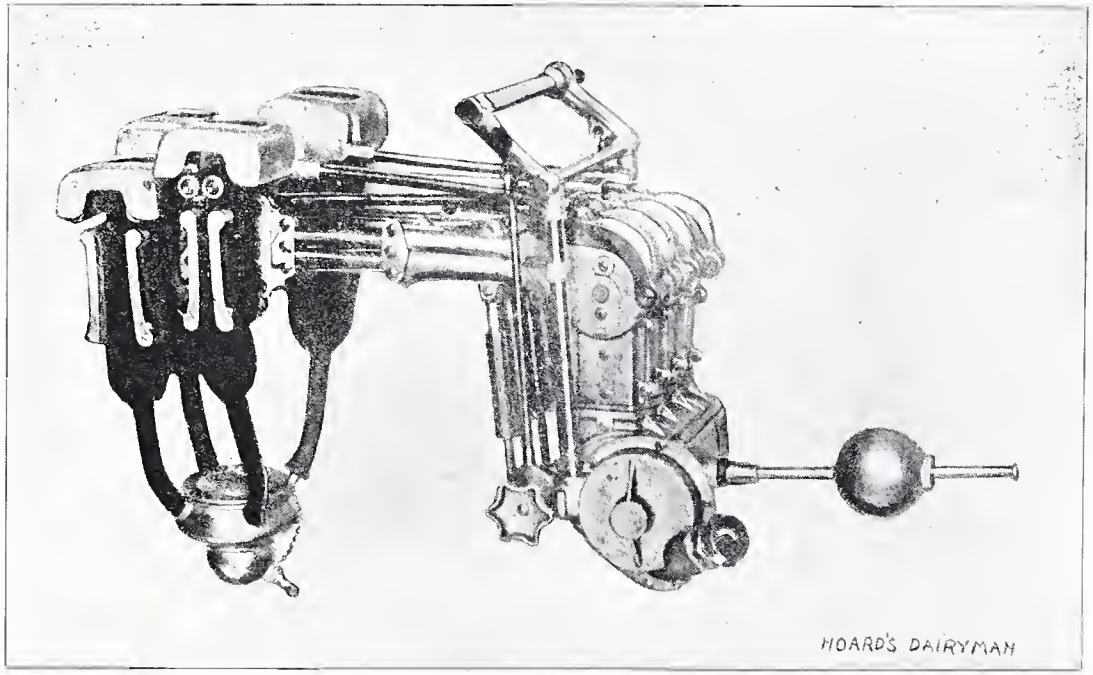

FIG. 17. Udder Attachment of the DeLaval Lactator.

by Mr. DeLavel;* the machine had at that time been in use for nearly a year at his farm. The milk is drawn by means of pressure and agitation of the teats and the base of the udder with this machine, and not by suction, as in the case of the two machines just described. At the time the description was published it was confidently hoped that the Lactator would solve the milking-machine problem, but the expectations of the inventor and the dairy public were not realized; some difficulties, which it was thought could be readily overcome, proved unsurmountable, and so far as is known, the inventor abandoned work on it a year or two later. The machine is, therefore, now only of interest historically.

The *Wright Machine* doubtless antedated the milking machines mentioned in the preceding by a generation or more, but it was never, I believe, put on the market or patented. It is referred to in a recent communication by the well-known Wisconsin dairyman, C. P. Goodrich,† as follows:

"The first milking machine of which I have any knowledge was invented about fifty-five years ago by Charles Wright, who was living at the time near Fort Atkinson, Wis. But, although Mr. Wright lived and died in the firm belief that it was a success and that he had conferred a great boon on his fellow men in the way of saving much labor, yet the machine was a failure and was never used to any extent after the inventor's cows had dried up and he himself was dead."

RECENT MILKING MACHINES.

There are at least three different styles of machines not previously mentioned which may justly claim our attention and which are now prominently before the dairy public, viz, the Lawrence-Kennedy Milking Machine, the Sharples and the Mehring Machines. Of these, the last two have not as yet been placed on the market, except in a limited way, and may still be considered in the experimental stage, while the first one, so far as I have been able to learn, has not yet been introduced into American dairies.

The *Lawrence-Kennedy Patent "Universal" Cow-Milker* (U. S. patents Nos. 642,044 and 646,183, see Fig. 18), is a Scotch machine, the inventors being W. H. Lawrence and R. Kennedy, of Glasgow. We know of its merits only through reports from foreign countries. It is pronounced an unqualified success from Australia and is endorsed by the dairy writer and teacher, H. W. Potts, principal of the Hawesbury Agricultural College, N. S. W., who considers the machine "simple, reliable, durable and practically successful."* In

*Hoard's Dairyman, Oct. 13, 1896.
†Wisconsin Agriculturist, Dec. 18, 1902.

a recent address on "Dairying, Its Relation to General Farming," Mr. Potts gives thirteen points in favor of dairying, the last one being: "That the labor and difficulty in milking cows is now prac-

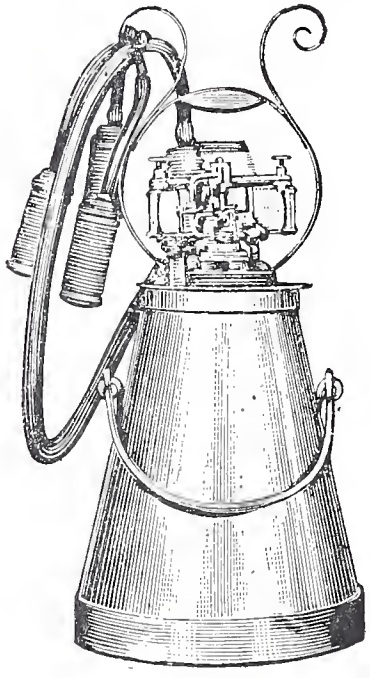

FIG. 18. Pail and Teat Cups Used in the Lawrence-Kennedy Milking Machine.

tically solved by the introduction of a cheap, effective and easy-working milking machine (the Lawrence-Kennedy.)"

On the other hand, it may be stated that the New Zealand Dairyman, giving a summary of this lecture, comments especially on this point as follows:†

"We do not lay very much stress on number thirteen; it is a bad number any way, as so far as any information we have been able to gather, it tends in an opposite direction."

Along the same line, a correspondent to Hoard's Dairyman writes from Australia:‡ "A great number of dairymen have had their sheds fitted up with machines during the last year or two and, for a time, everything seemed to go along perfectly, but now a number of machines are standing idle, and hand-milking has been resumed. * * * The apparent trouble seems to arise from the fact of the cows, when in the full flush of the season, not giving down their milk properly to the machine, and, singular to say, this applies to cows that have been machine-milked before being turned out prior to the last calving. The main fault seems to lie in the action of the teat cups, to which the animals gradually acquire a dislike, and,

*Hoard's Dairyman, Nov. 7, 1902.
†March, 1903.
‡April 10, 1903.

after giving down from half to three-quarters of their milk, they instantly cut off the supply. It is stated that if the cow is at once stripped by hand, very little milk is obtained, but if left alone for five to ten minutes after the teat cups are removed, a hand-milker can obtain all the rest of her milk."

In the same number of the Hoard's Dairyman, a correspondent from England states that there are over five hundred of the Lawrence-Kennedy machines in use in Australia, and about ninety in England at the present time. "I went down to a place called Gillingham's, in Dorset, to see it work; the machine had been installed at his dairy for nearly two years, so I thought it would be a good place to go, as they had cows that had been milked by the machine before calving and had since freshened and were again being milked by the machine.

"I saw forty cows milked at this place in twenty-five minutes (with eight machines) by a man to put the teat cups on, and a boy to carry the milk to the dairy. The machine got practically all the milk; the cows were stripped out afterward and a gallon and a half was all that was got from the forty cows.

"The owner of the dairy told me he considered it saved him a lot of money and time, and that since using the machine he has had no three-teaters, no sore teats or cow pox and that there is no question but what the milk is much cleaner and keeps better."

It is evident that there is no difficulty in obtaining evidence on both sides of the question, and it is well, therefore, to be somewhat skeptical as to reports that lead to generalizations from limited experiences, as to variety of conditions, time under observation, etc. In the last report quoted, the time stated evidently included that of drawing the milk only; it should also be remembered that a gallon and a half of strippings is as good as a gallon of most of the cream sold in our larger cities and would contain as much butter-fat as four gallons of ordinary milk, or eight gallons for the day, if the cows were milked twice. The machines referred to in the last correspondence may have been further perfected than those in use in Australian dairies that are reported to have been discarded.

From the description of the Lawrence-Kennedy machine which are available, it appears that the outfit consists of the driving power (steam engine, electricity, horse power, etc.); a suction-producing apparatus (vacuum pump or ejector worked by steam or water pressure); vacuum regulating appliances; milk pails, pulsators, teat cups, with connections; and vacuum reservoir, indicators and stable fittings. The machine acts through suction, the effort being to render its action as nearly similar to that of a sucking calf as possible; the teat cups are fitted with an inside lining of pliable rubber, which contracts and expands and is so arranged that the air pressure to

the teat is exerted downward from the udder to the point of the teat, producing a gentle drawing motion. A second pipe draws the milk away in an uninterrupted flow into the cans by suction.

It is possible that some difficulty with this and similar machines will arise from the use of rubber connections. According to the experience of a recent writer in Hoard's Dairyman,* (speaking of the use of rubber tube connections) "with all the aseptic precautions and antiseptic measures the rubber tubes would bear, we couldn't keep them sterile; if we got them sterile we destroyed the tubes very quickly." We are forced to conclude, at any rate, that the evidence as to the practicability of the Lawrence-Kennedy machine is not unanimous, and that in all probability it must undergo essential improvements before it can be pronounced a perfect success. With the small amount of accurate definite information on hand as to its practical operation, we can not say at the present time whether it will be possible to make such improvements.

The *Sharpless Sympathetic Pulsating Lactator* (see Figs. 19-22) is the latest addition to the list of milking machines. Having only recently been placed on the marked by the Dairy Specialty Company, of West Chester, Pa., no practical experience of the workings of

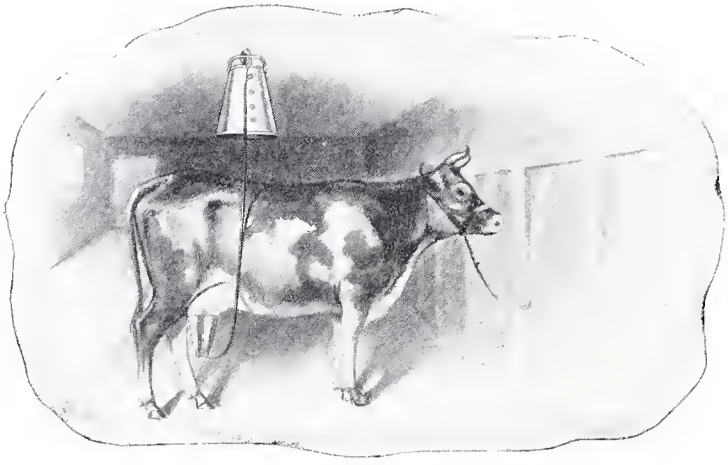

Fig. 19. The Sharpless Lactator.

the machine is as yet at hand, aside from such obtained in the experimental dairy of the inventor, where it has been applied in one shape or another for over two years. The claim is made by the manufacturers that it will enable one man, after both he and the dairy have become broken into the use of the apparatus, to handle as many cows as six or eight people will handle by hand-milking. The following description of the machine is culled from printed circulars or letters received from the manufacturers. The Lactator consists of an air pump requiring about one horse-power to operate it (the power used may be gasolene or steam engine,

*Cited in N. Y. Produce Review, April 1, 1903.

horse power, water power, etc.), a milk pail with tight lid and glass peep holes down the side (see Fig. 20), the pulsator, which "automaticaly adjusts all pressures and pulsations to the individual cow's characteristics," and the teat cups. The piping system is

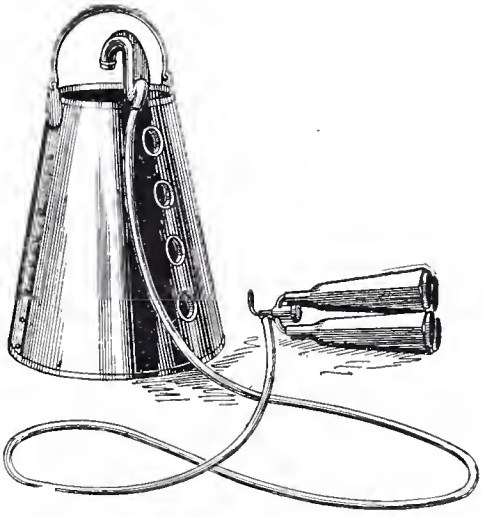

Fig. 20. The Sharpless Lactator Milkpail.

run from the vacuum pump over the different lines of stalls, and a drop pipe descends into each stall, terminating eighteen inches to two feet above the cow's back. The milk pails are hung on small fittings placed on the ends of each of these pipes. The connection between the teat cups, which are attached to the cow's teats, and

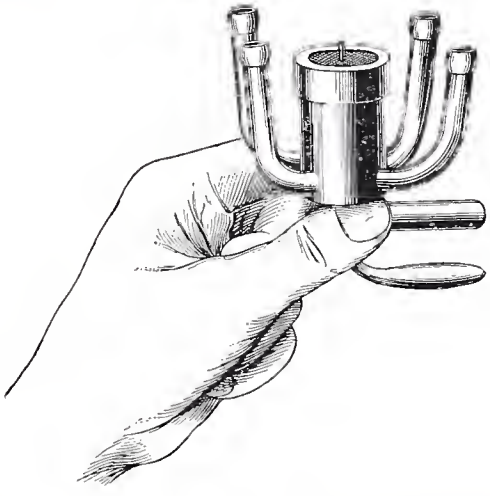

Fig. 21. The Sharpless Lactator "Pulsator."

the milk pails is made by means of a rubber tube. A one-horse-power engine is required for dairies of 100 cows or less. The cost of the apparatus is as follows: Vacuum pump and reservoir, $80.00; milk pails, with systematic pulsator, teat cups and connections, $40.00. and the same price for each additional pail. One extra pail

should be provided for each eight or ten cows. The machine, as made at present, is only adapted to advantage for use in large dairies of, say, fifty to one hundred cows or more.

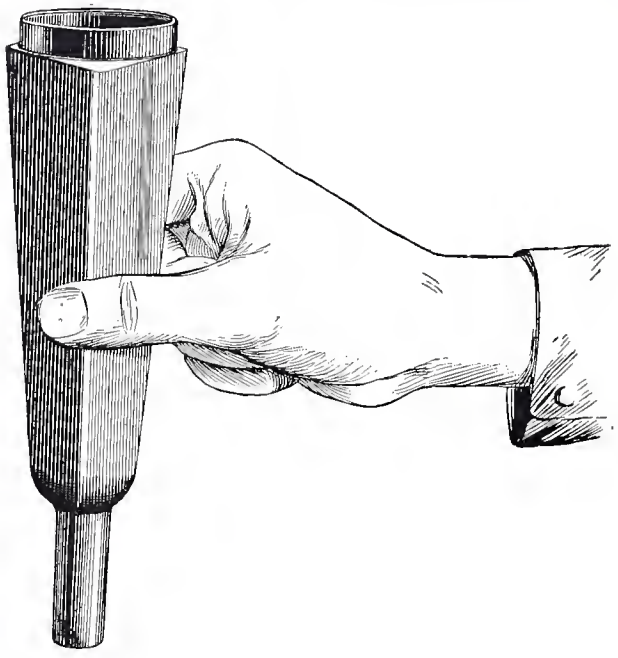

FIG. 22. The Sharpless Lactator Teat Cup.

The *Mehring Cow-Milker.*—The last milking machine to be mentioned is the "Mehring Improved Cow-Milker" (see Fig. 23), manu-

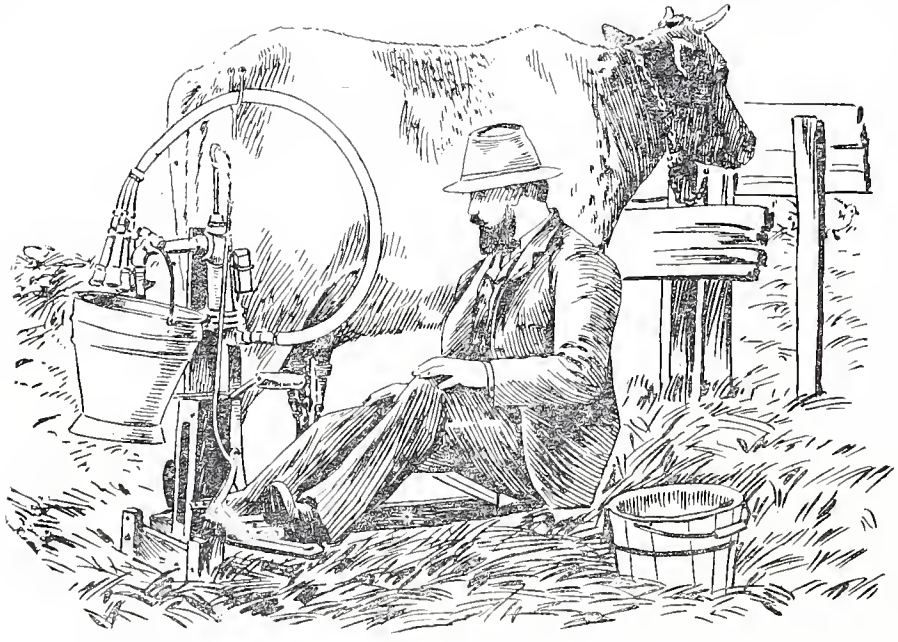

FIG. 23. The Mehring Cow-Milker Worked by Foot Power.

factured by Wm. M. Mehring, of York Road, Md. The first patent on this machine was granted December 12, 1892, (U. S. patent No.

488,282; later patents are Nos. 571,573 and 638,640). Unlike the machines previously mentioned, it is primarily intended for small herds, and there are no stationary fixtures about it. It was originally made in two forms, for hand power, "recommended to farmers who depend on their children to do most of the milking," and for foot power, "adapted where grown people do the milking." (See Fig. 23.) Of late the latter kind only has been manufactured, however, as it seemed to meet with more favor. The price of this machine is $75.00; it consists of an air pump, worked by foot power, two pieces of rubber hose and eight suction cups that are attached to the teats of two cows; these are thus milked at the same time, the operator, who sits between the two cows, working the pump with his feet and placing the teat cups against the teats. On opening the spigots the suction rapidly draws the cups over the teats and the milk begins to flow into the milk pail, which is hung on the spout of the pump.

The teat cup is made of three pieces, and is of hard rubber; to the small end of the cup a piece of glass tubing is attached, through which the milk may be seen, and this again is connected with a small rubber tube. By means of a spigot in the tube, suction may be shut off when the teat is empty. The milk is conveyed from the spigot to the head, where the milk from all four teats unites and passes into the large hose to the pail.

This milking machine has been in operation at a number of farms in the vicinity of Madison, Wis., for a year or more, and also in a few localities in the East. So far as I have been able to learn, it has given good satisfaction. Its simplicity of construction, as well as ease and rapidity of operation are strong points in its favor. One man working all alone will milk eight cows in fifteen minutes with the machine. The manufacturer writes that he expects to make some improvements in the machine during the present summer (1903), and that he will then begin to push its sale in the dairy sections of our country.

If either one of the milking machines mentioned in the preceding comes up to expectations, the dairy industry of this and other countries will be immensely benefited. At the present time we are, perhaps, not warranted in making any definite statement, but it seems possible that the problem of a mechanical milking apparatus may be solved in the near future, after having for half a century baffled the efforts of numerous inventors, some of whom have attained marked success with other children of their genius.

Hand-milking will never be entirely superseded by machine milking, however, except perhaps in large dairies, and the time is no doubt still distant when milking machines will generally take the place

of human milkers, even in such dairies. It is essential that milkers be taught the importance of, and practice exhaustive milking, whether the milking be done by machine or by hand; and a milking machine will be likely to require occasional critical examination as to the thoroughness with which its work is done. Whether the era of machine-milking is near or far off, therefore, there is a necessity of care and thoroughness in milking. It is the hope of the writer that the discussion entered into in this bulletin and the results of the investigations here presented will tend to bring this subject to the general attention of our dairymen, and thus aid in increasing the returns from the dairy and in raising the standard of production of our dairy cows.

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METHODS OF MILKING,

WITH SPECIAL REFERENCE TO THE MANIPULATION METHOD.

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